



# PRESIDENCY UNIVERSITY

Presidency University Act, 2013 of the Karnataka Act No. 41 of 2013 | Established under Section 2(f) of UGC Act, 1956

Approved by AICTE, New Delhi

## **PRESIDENCY SCHOOL OF ARTIFICIAL INTELLIGENCE AND ADVANCED COMPUTING**

### **Program Regulations and Curriculum 2026-2030**

#### **BACHELOR OF TECHNOLOGY (B.Tech.) in Artificial intelligence and Data Science**

**based on Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**

## Table of Contents

| Clause No.                          | Contents                                                                                                                             | Page Number |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|-------------|
| <b>PART A – PROGRAM REGULATIONS</b> |                                                                                                                                      |             |
| 1.                                  | Vision & Mission of the University and the School / Department                                                                       | 3           |
| 2.                                  | Preamble to the Program Regulations and Curriculum                                                                                   | 3           |
| 3.                                  | Short Title and Applicability                                                                                                        | 4           |
| 4.                                  | Definitions                                                                                                                          | 6           |
| 5.                                  | Program Description                                                                                                                  | 6           |
| 6.                                  | Minimum and Maximum Duration                                                                                                         | 7           |
| 7.                                  | Programme Educational Objectives (PEO)                                                                                               | 7           |
| 8.                                  | Programme Outcomes (PO) and Programme Specific Outcomes (PSO)                                                                        | 8           |
| 9.                                  | Admission Criteria (as per the concerned Statutory Body)                                                                             | 9           |
| 10.                                 | Lateral Entry / Transfer Students requirements                                                                                       | 10          |
| 11.                                 | Change of Branch / Discipline / Specialization                                                                                       | 12          |
| 12.                                 | Specific Regulations regarding Assessment and Evaluation                                                                             | 13          |
| 13.                                 | Additional clarifications - Rules and Guidelines for Transfer of Credits from MOOC, etc.                                             | 15          |
| <b>PART B: PROGRAM STRUCTURE</b>    |                                                                                                                                      |             |
| 14.                                 | Structure / Component with Credit Requirements Course Baskets & Minimum Basket wise Credit Requirements                              | 18          |
| 15.                                 | Minimum Total Credit Requirements of Award of Degree                                                                                 | 18          |
| 16.                                 | Other Specific Requirements for Award of Degree, if any, as prescribed by the Statutory Bodies                                       | 18          |
| <b>PART C: CURRICULUM STRUCTURE</b> |                                                                                                                                      |             |
| 17.                                 | Curriculum Structure – Basket Wise Course List                                                                                       | 19          |
| 18.                                 | Practical / Skill based Courses – Internships / Thesis / Dissertation / Capstone Project Work / Portfolio / Mini project             | 22          |
| 19.                                 | List of Elective Courses under various Specializations / Stream Basket                                                               | 25          |
| 20.                                 | List of Open Electives to be offered by the School / Department (Separately for ODD and EVEN Semesters).                             | 27          |
| 21.                                 | List of MOOC (NPTEL) Courses                                                                                                         | 35          |
| 22.                                 | Recommended Semester Wise Course Structure / Flow including the Program / Discipline Elective Paths / Options                        | 37          |
| 23.                                 | Course Catalogue of all Courses Listed including the Courses Offered by other School / Department and Discipline / Program Electives | 40          |

## **PART A – PROGRAM REGULATIONS**

### **1. Vision & Mission of the University and the School / Department**

#### ***1.1 Vision of the University***

To be a Value-driven Global University, excelling beyond peers and creating professionals of integrity and character, having concern and care for society.

#### ***1.2 Mission of the University***

- Commit to be an innovative and inclusive institution by seeking excellence in teaching, research and knowledge-transfer.
- Pursue Research and Development and its dissemination to the community, at large.
- Create, sustain and apply learning in an interdisciplinary environment with consideration for ethical, ecological and economic aspects of nation building.
- Provide knowledge-based technological support and services to the industry in its growth and development.
- To impart globally-applicable skill-sets to students through flexible course offerings and support industry's requirement and inculcate a spirit of new-venture creation.

#### ***1.3 Vision of Presidency School of Computer Science and Engineering***

To be a value based, practice-driven School of Computer Science and Engineering, committed to developing globally-competent Engineers, dedicated to transforming Society.

#### ***1.4 Mission of Presidency School of Computer Science and Engineering***

- Cultivate a practice-driven environment with a contemporary Learning-pedagogy, integrating theory and practice.
- Attract and nurture world-class faculty to excel in Teaching and Research, in the field of Core Computer Science and Engineering.
- Establish state-of-the-art facilities for effective Teaching and Learning-experiences.
- Promote Interdisciplinary Studies to nurture talent and impart relevant skill-sets for global impact.
- Instill Entrepreneurial and Leadership Skills to address Social, Environmental, and Community-needs.

### **2. Preamble to the Program Regulations and Curriculum**

This is the subset of Academic Regulations and it is to be followed as a requirement for the award of B. Tech degree.

The Curriculum is designed to take into the factors listed in the Choice Based CreditSystem (CBCS) with focus on Industrial Based Project Learning, Industrial Training, and Internship to enable the students to become eligible and fully equipped for employment in industries, choose higher studies or entrepreneurship.

In exercise of the powers conferred by and in discharge of duties assigned under the relevant provision(s) of the Act, Statutes and Academic Regulations of the University, the Academic Council hereby makes the following Regulations.

### **3. Short Title and Applicability**

- a. These Regulations shall be called the Bachelor of Technology Degree Program Regulations and Curriculum 2025-2029.

- b. These Regulations are subject to, and pursuant to the Academic Regulations.
- c. These Regulations shall be applicable to the ongoing Bachelor of Technology Degree Programs of the 2025-2029 batch, and to all other Bachelor of Technology Degree Programs which may be introduced in future.
- d. These Regulations shall supersede all the earlier Bachelor of Technology Degree Program Regulations and Curriculum, along with all the amendments thereto.
- e. These Regulations shall come into force from the Academic Year 2025-2029.

#### 4. Definitions

*In these Regulations, unless the context otherwise requires:*

- a. *"Academic Calendar" means the schedule of academic and miscellaneous events as approved by the Vice Chancellor;*
- b. *"Academic Council" means the Academic Council of the University;*
- c. *"Academic Regulations" means the Academic Regulations, of the University;*
- d. *"Academic Term" means a Semester or Summer Term;*
- e. *"Act" means the Presidency University Act, 2013;*
- f. *"AICTE" means All India Council for Technical Education;*
- g. *"Basket" means a group of courses bundled together based on the nature/type of the course;*
- h. *"BOE" means the Board of Examinations of the University;*
- i. *"BOG" means the Board of Governors of the University;*
- j. *"BOM" means the Board of Management of the University;*
- k. *"BOS" means the Board of Studies of a particular Department/Program of Study of the University;*
- l. *"CGPA" means Cumulative Grade Point Average as defined in the Academic Regulations;*
- m. *"Clause" means the duly numbered Clause, with Sub-Clauses included, if any, of these Regulations;*
- n. *"COE" means the Controller of Examinations of the University;*
- o. *"Course In Charge" means the teacher/faculty member responsible for developing and organising the delivery of the Course;*
- p. *"Course Instructor" means the teacher/faculty member responsible for teaching and evaluation of a Course;*
- q. *"Course" means a specific subject usually identified by its Course-code and Course-title, with specified credits and syllabus/course-description, a set of references, taught by some teacher(s)/course-instructor(s) to a specific class (group of students) during a specific Academic Term;*
- r. *"Curriculum Structure" means the Curriculum governing a specific Degree Program offered by the University, and, includes the set of Baskets of Courses along with minimum credit requirements to be earned under each basket for a degree/degree with specialization/minor/honours in addition to the relevant details of the Courses and Course catalogues (which describes the Course content and other important information about the Course). Any specific requirements for a particular program may be brought into the Curriculum structure of the specific program and relevant approvals should be taken from the BOS and Academic Council at that time.*
- s. *"DAC" means the Departmental Academic Committee of a concerned Department/Program of Study of the University;*
- t. *"Dean" means the Dean / Director of the concerned School;*
- u. *"Degree Program" includes all Degree Programs;*
- v. *"Department" means the Department offering the degree Program(s) / Course(s) / School offering the concerned Degree Programs / other Administrative Offices;*

- w. *"Discipline" means specialization or branch of B.Tech. Degree Program;*
- x. *"HOD" means the Head of the concerned Department;*
- y. *"L-T-P-C" means Lecture-Tutorial-Practical-Credit – refers to the teaching – learning periods and the credit associated;*
- z. *"MOOC" means Massive Open Online Courses;*
- aa. *"MOU" means the Memorandum of Understanding;*
- bb. *"NPTEL" means National Program on Technology Enhanced Learning;*
- cc. *"Parent Department" means the department that offers the Degree Program that a student undergoes;*
- dd. *"Program Head" means the administrative head of a particular Degree Program/s;*
- ee. *"Program Regulations" means the Bachelor of Technology Degree Program Regulations and Curriculum, 2025-2029;*
- ff. *"Program" means the Bachelor of Technology (B.Tech.) Degree Program;*
- gg. *"PSCSE" means the Presidency School of Computer Science and Engineering;*
- hh. *"Registrar" means the Registrar of the University;*
- ii. *"School" means a constituent institution of the University established for monitoring, supervising and guiding, teaching, training and research activities in broadly related fields of studies;*
- jj. *"Section" means the duly numbered Section, with Clauses included in that Section, of these Regulations;*
- kk. *"SGPA" means the Semester Grade Point Average as defined in the Academic Regulations, 2021;*
- ll. *"Statutes" means the Statutes of Presidency University;*
- mm. *"Sub-Clause" means the duly numbered Sub-Clause of these Program Regulations;*
- nn. *"Summer Term" means an additional Academic Term conducted during the summer break (typically in June-July) for a duration of about eight (08) calendar weeks, with a minimum of thirty (30) University teaching days;*
- oo. *"SWAYAM" means Study Webs of Active Learning for Young Aspiring Minds.*
- pp. *"UGC" means University Grant Commission;*
- qq. *"University" means Presidency University, Bengaluru; and*
- rr. *"Vice Chancellor" means the Vice Chancellor of the University.*

## 5. Program Description

The Bachelor of Technology Degree Program Regulations and Curriculum 2025-2029 are subject to, and, pursuant to the Academic Regulations. These Program Regulations shall be applicable to the following ongoing Bachelor of Technology (B.Tech.) Degree Programs of 2025-2029 offered by the Presidency School of Computer Science and Engineering (PSCS):

1. Bachelor of Technology in Computer Science and Engineering, abbreviated as CSE
2. Bachelor of Technology in Computer Science and Technology (Big Data), abbreviated as CBD
3. Bachelor of Technology in Computer Science and Engineering (Block Chain), abbreviated as CBC
4. Bachelor of Technology in Computer Science and Technology (Dev Ops), abbreviated as CDV
5. Bachelor of Technology in Computer Science and Engineering (Cyber Security), abbreviated as CCS
6. Bachelor of Technology in Computer Science and Engineering (Internet of Things), abbreviated as CIT
7. Bachelor of Technology in Computer Science and Engineering (Data Science), abbreviated as CSD
8. Bachelor of Technology in Computer Science and Technology, abbreviated as CSG
9. Bachelor of Technology in Information Science and Technology, abbreviated as IST

10. Bachelor of Technology in Computer Science and Information Technology, abbreviated as CSI
11. Bachelor of Technology in Computer Science and Engineering (Networks), abbreviated as CSN
12. Bachelor of Technology in Computer Engineering, abbreviated as COM
13. Bachelor of Technology in Information Science and Engineering, abbreviated as ISE and
14. Bachelor of Technology in Computer Science and Engineering (Artificial Intelligence and Machine Learning) abbreviated as CAI
15. Bachelor of Technology in Robotics and Artificial Intelligence Engineering, abbreviated as RAI
16. Bachelor of Technology in Artificial Intelligence and Data Science Engineering, abbreviated as AID

5.1 These Program Regulations shall be applicable to other similar programs, which may be introduced in future.

5.2 These Regulations may evolve and get amended or modified or changed through appropriate approvals from the Academic Council, from time to time, and shall be binding on all concerned.

5.3 The effect of periodic amendments or changes in the Program Regulations, on the students admitted in earlier years, shall be dealt with appropriately and carefully, so as to ensure that those students are not subjected to any unfair situation whatsoever, although they are required to conform to these revised Program Regulations, without any undue favour or consideration.

## **6. Minimum and Maximum Duration**

- 6.1 Bachelor of Technology Degree Program is a Four-Year, Full-Time Semester based program. The minimum duration of the B.Tech. Program is four (04) years and each year comprises of two academic Semesters (Odd and Even Semesters) and hence the duration of the B.Tech. program is eight (08) Semesters.
- 6.2 A student who for whatever reason is not able to complete the Program within the normal period or the minimum duration (number of years) prescribed for the Program, may be allowed a period of two years beyond the normal period to complete the mandatory minimum credits requirement as prescribed by the concerned Program Regulations and Curriculum. In general, the permissible maximum duration (number of years) for completion of Program is 'N' + 2 years, where 'N' stands for the normal or minimum duration (number of years) for completion of the concerned Program as prescribed by the concerned Program Regulations and Curriculum.
- 6.3 The time taken by the student to improve Grades/CGPA, and in case of temporary withdrawal/re-joining (Refer to Clause 16.1 of Academic Regulations), shall be counted in the permissible maximum duration for completion of a Program.
- 6.4 In exceptional circumstances, such as temporary withdrawal for medical exigencies where there is a prolonged hospitalization and/or treatment, as certified through hospital/medical records, women students requiring extended maternity break (certified by registered medical practitioner), and, outstanding sportspersons representing the University/State/India requiring extended time to participate in National/International sports events, a further extension of one (01) year may be granted on the approval of the Academic Council.
- 6.5 The enrolment of the student who fails to complete the mandatory requirements for the award of the concerned Degree (refer Section 19.0 of Academic Regulations) in the prescribed maximum duration (Sub-Clauses 18.1 and 18.2 of Academic Regulations), shall stand terminated and no Degree shall be awarded.

## 7 Programme Educational Objectives (PEO)

After four years of successful completion of the program, the graduates shall be able to:

**PEO 1:** Demonstrate proficiency as a Computer Engineering professional, applying technical knowledge and skills effectively in various engineering fields.

**PEO 2:** Become a teaching and research professional in the areas of Computer Science and Engineering, engaging in lifelong learning to stay at the forefront of the field.

**PEO 3:** Contribute as a key member of a consultancy team in the Computer Science and Engineering industry, providing expert solutions to complex problems.

**PEO 4:** Emerge as an entrepreneur in the fields of Computer Science and related areas, creating innovative solutions and businesses.

## 8 Programme Outcomes (PO) and Programme Specific Outcomes (PSO)

### 8.1 Programme Outcomes (PO)

On successful completion of the Program, the students shall be able to:

**P01: Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.

**P02: Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

**P03: Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

**P04: Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

**P05: Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

**P06: The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

**P07: Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

**P08: Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

**P09: Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

**P010: Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

**P011: Life-Long Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

## **8.2 Program Specific Outcomes(PSOs):**

On successful completion of the Program, the students shall be able to:

**PSO 01:** Display a strong grasp of computer science fundamentals to clearly explain essential concepts, analyze problems, and utilize theory to model and construct reliable, efficient computing systems.

**PSO 02:** Leverage on their programming abilities, knowledge of software development platforms, and understanding of cybersecurity principles to design practical solutions, supporting diverse paths in industry, academia, advanced studies, research, or entrepreneurship.

**PSO 03:** Comprehend and evaluate the ethical, legal, societal implications of cybersecurity practices to ensure responsible decision-making while designing, implementing, applications that protect data, networks, and infrastructure against cyber threats.

## **9 Admission Criteria (as per the concerned Statutory Body)**

The University admissions shall be open to all persons irrespective of caste, class, creed, gender or nation. All admissions shall be made on the basis of merit in the qualifying examinations; provided that forty percent of the admissions in all Programs of the University shall be reserved for the students of Karnataka State and admissions shall be made through a Common Entrance Examination conducted by the State Government or its agency and seats shall be allotted as per the merit and reservation policy of the State Government from time to time. The admission criteria to the B.Tech. Program is listed in the following Sub-Clauses:

- 9.1 An applicant who has successfully completed Pre-University course or Senior Secondary School course (+2) or equivalent such as (11+1), 'A' level in Senior School Leaving Certificate Course from a recognized university of India or outside or from Senior Secondary Board or equivalent, constituted or recognized by the Union or by the State Government of that Country for the purpose of issue of qualifying certificate on successful completion of the course, may apply for and be admitted into the Program.
- 9.2 Provided further, the applicant must have taken Physics and Mathematics as compulsory subjects in the Pre-University / Higher Secondary / (10+2) / (11+1) examination, along with either Chemistry / Biology / Electronics / Computer Science / Biotechnology subject, and, the applicant must have obtained a minimum of 45% of the total marks (40% in case of candidates belonging to the Reserved Category as classified by the Government of Karnataka) in these subjects taken together.
- 9.3 The applicant must have appeared for Joint Entrance Examinations (JEE) Main / JEE (Advanced) / Karnataka CET / COMED-K, or any other State-level Engineering Entrance Examinations.
- 9.4 Reservation for the SC / ST and other backward classes shall be made in accordance with the directives issued by the Government of Karnataka from time to time.
- 9.5 Admissions are offered to Foreign Nationals and Indians living abroad in accordance with the rules applicable for such admission, issued from time to time, by the Government of India.

- 9.6 Candidates must fulfil the medical standards required for admission as prescribed by the University.
- 9.7 If, at any time after admission, it is found that a candidate had not in fact fulfilled all the requirements stipulated in the offer of admission, in any form whatsoever, including possible misinformation and any other falsification, the Registrar shall report the matter to the Board of Management (BOM), recommending revoking the admission of the candidate.
- 9.8 The decision of the BOM regarding the admissions is final and binding.

## **10 Lateral Entry / Transfer Students requirements**

### **10.1 Lateral Entry**

The University admits students directly to the second year (3<sup>rd</sup> Semester) of the B.Tech. Degree program as per the provisions and/or regulations of the Government of Karnataka pertaining to the “Lateral Entry” scheme announced by the Government from time to time. Further, the general conditions and rules governing the provision of Lateral Entry to the B.Tech. Program of the University are listed in the following Sub-Clauses:

- 10.1.1 Admission to 2<sup>nd</sup> year (3<sup>rd</sup> Semester) of the B.Tech. Degree program shall be open to the candidates who are holders of a 3-year Diploma in Engineering (or equivalent qualification as recognized by the University), who have secured not less than forty-five percentage (45%) marks in the final year examination (5<sup>th</sup> and 6<sup>th</sup> Semesters of the Diploma Program) in the appropriate branch of Engineering. Provided that, in case of SC / ST and OBC candidates from Karnataka the minimum marks for eligibility shall be forty percent (40%).
- 10.1.2 Provided further that, candidates seeking Lateral Entry may be required to complete specified bridge Courses as prescribed by the University. Such bridge Courses, if any, shall not be included in the CGPA computations.
- 10.1.3 All the existing Regulations and Policies of the University shall be binding on all the students admitted to the Program through the provision of Lateral Entry.
- 10.1.4 The Course requirements prescribed for the 1<sup>st</sup> Year of the B.Tech. Program shall be waived for the student(s) admitted through Lateral Entry and the duration of the B.Tech. Program for such students is three (03) years, commencing from the 3<sup>rd</sup> Semester (commencement of the 2<sup>nd</sup> Year) of the B.Tech. Program and culminating with the 8<sup>th</sup> Semester (end of the 4<sup>th</sup> Year) of the B.Tech. Program.
- 10.1.5 Provided that, if a Lateral Entry student misses any mandatory program specific courses that are typically offered in the 1<sup>st</sup> year (1<sup>st</sup> or 2<sup>nd</sup> semesters), then those courses must be cleared by the students as soon as possible, preferably during the Summer Term.
- 10.1.6 The existing Program Regulations of the concerned Program to which the student is admitted through the provision of Lateral Entry shall be binding on the student with effect from the 3<sup>rd</sup> Semester of the Program. i.e., the Program Structure and Curriculum from the 3<sup>rd</sup> to 8<sup>th</sup> Semesters of the Program concerned shall be binding on the student admitted through Lateral Entry. Further, any revisions / amendments made to the Program Regulations thereafter, shall be binding on all the students of the concerned Program.
- 10.1.7 All the Courses (and the corresponding number of Credits) prescribed for the 1<sup>st</sup> Year of the

concerned B.Tech. Program shall be waived for the student(s) admitted to the concerned B.Tech Program through Lateral Entry. Further, the *Minimum Credit Requirements* for the award of the B.Tech. Degree in the concerned Program shall be prescribed / calculated as follows:

The ***Minimum Credit Requirements*** for the award of the Bachelor of Technology (B.Tech.) Degree prescribed by the concerned Bachelor of Technology Degree Program Regulations and Curriculum, 2024-2028, minus the number of Credits prescribed / accepted by the Equivalence Committee for the 1<sup>st</sup> Year (1<sup>st</sup> and 2<sup>nd</sup> Semesters) of the B.Tech. Program.

For instance, if the *Minimum Credit Requirements* for the award of the Bachelor of Technology (B.Tech.) Degree as prescribed by the Regulations for B.Tech. (Computer Science and Engineering-Cyber Security) is “N” Credits, and, if the total credits prescribed in the 1<sup>st</sup> Year (total credits of the 1<sup>st</sup> and 2<sup>nd</sup> Semesters) of the Program concerned is “M” Credits, then the *Minimum Credit Requirements* for the award of the B.Tech. in Computer Science and Engineering for a student who joins the Program through the provision of the Lateral Entry, shall be “N – M” Credits.

- 10.1.8 Further, no other waiver except the Courses prescribed for the 1<sup>st</sup> year of the B.Tech. Program of the University shall be permissible for students joining the B.Tech. Program through the provision of Lateral Entry.

## **10.2 Transfer of student(s) from another recognized University to the 2<sup>nd</sup> year (3<sup>rd</sup> Semester) of the B.Tech. Program of the University**

A student who has completed the 1<sup>st</sup> Year (i.e., passed in all the Courses / Subjects prescribed for the 1<sup>st</sup> Year) of the B.Tech/B.E/B.S., Four-Year Degree Program from another recognized University, may be permitted to transfer to the 2<sup>nd</sup> Year (3<sup>rd</sup> Semester) of the B.Tech. Program of the University as per the rules and guidelines prescribed in the following Sub-Clauses:

- 10.2.1 The concerned student fulfils the criteria specified in Sub-Clauses 10.1.1, 10.1.2 and 10.1.3.
- 10.2.2 The student shall submit the Application for Transfer along with a non-refundable Application Fee (as prescribed by the University from time to time) to the University no later than July 10 of the concerned year for admission to the 2<sup>nd</sup> Year (3<sup>rd</sup> Semester) B.Tech. Program commencing on August 1 on the year concerned.
- 10.2.3 The student shall submit copies of the respective Marks Cards / Grade Sheets / Certificates along with the Application for Transfer.
- 10.2.4 The transfer may be provided on the condition that the Courses and Credits completed by the concerned student in the 1<sup>st</sup> Year of the B.Tech. / B.E. / B.S. Four Degree Program from the concerned University, are declared equivalent and acceptable by the Equivalence Committee constituted by the Vice Chancellor for this purpose. Further, the Equivalence Committee may also prescribe the Courses and Credits the concerned students shall have to mandatorily complete, if admitted to the 2<sup>nd</sup> Year of the B.Tech. Program of the University.

- 10.2.5 The Branch / Discipline allotted to the student concerned shall be the decision of the University and binding on the student.

## **11 Change of Branch / Discipline / Specialization**

A student admitted to a particular Branch of the B.Tech. Program will normally continue studying in that Branch till the completion of the program. However, the University reserves the right to provide the option for a change of Branch, or not to provide the option for a change of Branch, at the end of 1<sup>st</sup> Year of the B.Tech. Program to eligible students in accordance with the following rules and guidelines framed by the University from time to time.

- 11.1** Normally, only those students, who have passed all the Courses prescribed for the 1<sup>st</sup> Year of the B.Tech. Program and obtained a CGPA of not less than 6.50 at the end of the 2<sup>nd</sup> Semester, shall be eligible for consideration for a change of Branch.
- 11.2** Change of Branch, if provided, shall be made effective from the commencement of the 3<sup>rd</sup> Semester of the B.Tech. Program. There shall be no provision for change of Branch thereafter under any circumstances whatsoever.
- 11.3** The student provided with the change of Branch shall fully adhere to and comply with the Program Regulations of the concerned Branch of the B.Tech. Program, the Fee Policy pertaining to that Branch of the B.Tech. Program, and, all other rules pertaining to the changed Branch existing at the time.
- 11.4** Change of Branch once made shall be final and binding on the student. No student shall be permitted, under any circumstances, to refuse the change of Branch offered.
- 11.5** The eligible student may be allowed a change in Branch, strictly in order of *inter se* merit, subject to the conditions given below:
- 11.5.1 The actual number of students in the 3<sup>rd</sup> Semester in any particular Branch to which the transfer is to be made, should not exceed the intake fixed by the University for the concerned Branch;
- 11.5.2 The actual number of students in any Branch from which transfer is being sought does not fall below 75% of the total intake fixed by the University for the concerned Branch.

The process of change of Branch shall be completed within the first five days of Registration for the 3<sup>rd</sup> Semester of the B.Tech. Program.

## 12 Specific Regulations regarding Assessment and Evaluation(including the Assessment Details of NTCC Courses, Weightages of Continuous Assessment and End Term Examination for various Course Categories)

12.1 The academic performance evaluation of a student in a Course shall be according to the University Letter Grading System based on the class performance distribution in the Course.

12.2 Academic performance evaluation of every registered student in every Course registered by the student is carried out through various components of Assessments spread across the Semester. The nature of components of Continuous Assessments and the weightage given to each component of Continuous Assessments (refer Clause 8.8 of Academic regulations) shall be clearly defined in the Course Plan for every Course, and approved by the DAC.

12.3 Format of the End-Term examination shall be specified in the Course Plan.

12.4 Grading is the process of rewarding the students for their overall performance in each Course. The University follows the system of Relative Grading with statistical approach to classify the students based on the relative performance of the students registered in the concerned Course except in the following cases:

- Non-Teaching Credit Courses (NTCC)
- Courses with a class strength less than 30

Absolute grading method may be adopted, where necessary with prior approval of concerned DAC.

Grading shall be done at the end of the Academic Term by considering the aggregate performance of the student in all components of Assessments prescribed for the Course. Letter Grades (Clause 8.10 of Academic Regulations) be awarded to a student based on her/his overall performance relative to the class performance distribution in the concerned Course. These Letter Grades not only indicate a qualitative assessment of the student's performance but also carry a quantitative (numeric) equivalent called the Grade Point.

### 12.5 Assessment Components and Weightage

| S. No | Credit Structure [L-T-P-C] | Percent age/ Marks | CA     |           | Mid-Term |           | End-term |           | Project | Total | Exam Conducted by                                     |
|-------|----------------------------|--------------------|--------|-----------|----------|-----------|----------|-----------|---------|-------|-------------------------------------------------------|
|       |                            |                    | Theory | Practical | Theory   | Practical | Theory   | Practical |         |       |                                                       |
| 1     | 3-0-0-3                    | Percent age        | 25%    | -         | 25%      | -         | 50%      | -         | -       | 100%  | Mid-Term & End Term by CoE                            |
|       |                            | Marks              | 50     | -         | 50       | -         | 100      | -         | -       | 200   |                                                       |
| 2     | 2-0-2-3                    | Percent age        | 12.50% | 12.50%    | 12.50%   | 12.50%    | 25%      | 25%       | -       | 100%  | Mid-Term & End Term by CoE *<br>Except for full stack |
|       |                            | Marks              | 25     | 25        | 25       | 25        | 50       | 50        | -       | 200   |                                                       |

|   |         |                |         |            |     |     |     |     |     |          |     |                                                         |
|---|---------|----------------|---------|------------|-----|-----|-----|-----|-----|----------|-----|---------------------------------------------------------|
|   |         |                |         |            |     |     |     |     |     |          |     | course<br>s                                             |
| 3 | 1-0-4-3 | Percent<br>age | -       | 25%        | 10% | 40% | 5%  | 20% | -   | 100<br>% | 100 | Mid-<br>Term<br>& End<br>Term<br>by<br>School           |
|   |         | Marks          | -       | 25         | 10  | 40  | 5   | 25  | -   |          |     |                                                         |
| 4 | 2-0-4-4 | Percent<br>age | 12.50%  | 12.50<br>% | 10% | 15% | 20% | 30% | -   | 100<br>% | 200 | *Mid-<br>Term<br>& End<br>Term<br>by CoE                |
|   |         | Marks          | 25      | 25         | 20  | 30  | 40  | 60  | -   |          |     |                                                         |
| 5 | 0-0-4-2 | Percent<br>age | -       | 50%        | -   | -   | -   | -   | 50% | 100<br>% | 100 | Project<br>evalua<br>ted by<br>IC at<br>School<br>level |
|   |         | Marks          | -       | 50         | -   | -   | -   | -   | 50  |          |     |                                                         |
| 6 | 0-0-2-1 | Percent<br>age | -       | 100%       | -   | -   | -   | -   | -   | 100<br>% | 100 | Only<br>CA at<br>School<br>Level                        |
|   |         | Marks          | -       | 100        | -   | -   | -   | -   | -   |          |     |                                                         |
| 7 | 3-0-2-4 | Percent<br>age | 12.50%  | 12.50<br>% | 15% | 10% | 30% | 20% | -   | 100<br>% | 200 | Mid-<br>Term<br>& End<br>Term<br>by CoE                 |
|   |         | Marks          | 25      | 25         | 30  | 20  | 60  | 40  | -   |          |     |                                                         |
| 8 | 2-0-0-2 | Percentag<br>e | 25<br>% | -          | 25% | -   | 50% | -   | -   | 100<br>% | 200 | Mid-Term<br>& End<br>Term by<br>CoE                     |
|   |         | Marks          | 50      | -          | 50  | -   | 100 | -   | -   |          |     |                                                         |
|   |         |                |         |            |     |     |     |     |     |          |     |                                                         |

\*CSS3426-Front End Full stack development

CSS3427-Java Full Stack Development

CSS3428-.Net Full Stack development

The exact weightages of Evaluation Components shall be clearly specified in the concerned PRC and respective Course Plan.

Normally, for Practice/Skill based Courses, without a defined credit structure (L-T-P) [NTCC], but with assigned Credits (as defined in Clause 5.2 of the Academic Regulations), the method of evaluation shall be based only on Continuous Assessments. The various components of Continuous Assessments, the distribution of weightage among such components, and the method of evaluation/assessment, shall be as decided and indicated in the Course Plan/PRC. The same shall be approved by the respective DAC.

## 12.6 Minimum Performance Criteria:

### 12.6.1 Theory only Course and Lab/Practice Embedded Theory Course

A student shall satisfy the following minimum performance criteria to be eligible to earn the credits towards the concerned Course:

- a. A student must obtain a minimum of 30% of the total marks/weightage assigned to the End Term Examinations in the concerned Course.
- b. The student must obtain a minimum of 40% of the AGGREGATE of the marks/weightage of the components of Continuous Assessments, Mid Term Examinations and End Term Examinations in the concerned Course.

#### **12.6.2 Lab/Practice only Course and Project Based Courses**

The student must obtain a minimum of 40% of the AGGREGATE of the marks/weightage of all assessment components in the concerned Course.

- 12.6.3 A student who fails to meet the minimum performance criteria listed above in a Course shall be declared as “Fail” and given “F” Grade in the concerned Course. For theory Courses, the student shall have to re-appear in the “Make-Up Examinations” as scheduled by the University in any subsequent semester, or, re-appear in the End Term Examinations of the same Course when it is scheduled at the end of the following Semester or Summer Term, if offered. The marks obtained in the Continuous Assessments (other than the End Term Examination) shall be carried forward and be included in computing the final grade, if the student secures the minimum requirements (as per sub-clauses 12.6.1 and 8.9.2 of Academic Regulations) in the “Make-Up Examinations” of the concerned Course. Further, the student has an option to re-register for the Course and clear the same in the summer term/ subsequent semester if he/she wishes to do so, provided the Course is offered.

### **13 Additional clarifications - Rules and Guidelines for Transfer of Credits from MOOC, etc. – Note: These are covered in Academic Regulations**

The University allows students to acquire credits from other Indian or foreign institutions and/or Massive Open Online Course(MOOC) platforms, subject to prior approval. These credits may be transferred and counted toward fulfilling the minimum credit requirements for the award of a degree. The process of transfer of credits is governed by the following rules and guidelines:

- 13.1 The transfer of credits shall be examined and recommended by the Equivalence Committee (Refer ANNEXURE B of Academic Regulations) and approved by the Dean - Academics.
- 13.2 Students may earn credits from other Indian or foreign Universities/Institutions with which the University has an MOU, and that MOU shall have specific provisions, rules and guidelines for transfer of credits. These transferred credits shall be counted towards the minimum credit requirements for the award of the degree.
- 13.3 Students may earn credits by registering for Online Courses offered by *Study Web of Active Learning by Young and Aspiring Minds* (SWAYAM) and *National Program on Technology Enhanced Learning* (NPTEL), or other such recognized Bodies/ Universities/Institutions as approved by the concerned BOS and Academic Council from time to time. The concerned School/Parent Department shall publish/include the approved list of Courses and the rules and guidelines governing such transfer of credits of the concerned Program from time to time. The Rules and Guidelines for the transfer of credits specifically from the Online

Courses conducted by SWAYAM/ NPTEL/ other approved MOOCs are as stated in the following Sub-Clauses:

- 13.3.1 A student may complete SWAYAM/NPTEL/other approved MOOCs as mentioned in Clause 13.3 (As per Academic Regulations) and transfer equivalent credits to partially or fully complete the mandatory credit requirements of Discipline Elective Courses and/or the mandatory credit requirements of Open Elective Courses as prescribed in the concerned Curriculum Structure. However, it is the sole responsibility of the student to complete the mandatory credit requirements of the Discipline Elective Courses and the Open Elective Courses as prescribed by the Curriculum Structure of the concerned Program.
- 13.3.2 SWAYAM/NPTEL/ other approved MOOCs as mentioned in Clause 13.3 (As per Academic Regulations) shall be approved by the concerned Board of Studies and placed (as Annexures) in the concerned PRC.
- 13.3.3 Parent Departments may release a list of SWAYAM/NPTEL/other approved MOOCs for Pre-Registration as per schedule in the Academic Calendar or through University Notification to this effect.
- 13.3.4** Students may Pre-Register for the SWAYAM/NPTEL/other approved MOOCs in the respective Departments and register for the same Courses as per the schedule announced by respective Online Course Offering body/institute/university.
- 13.3.5 A student shall request for transfer of credits only from such approved Courses as mentioned in Sub-Clause 13.3.2 above.
- 13.3.6 SWAYAM/NPTEL/other approved MOOCs Courses are considered for transfer of credits only if the concerned student has successfully completed the SWAYAM/NPTEL/other approved MOOCs and obtained a certificate of successful/satisfactory completion.
- 13.3.7 A student who has successfully completed the approved SWAYAM/NPTEL/ other approved MOOCs and wants to avail the provision of transfer of equivalent credits, must submit the original Certificate of Completion, or such similar authorized documents to the HOD concerned, with a written request for the transfer of the equivalent credits. On verification of the Certificates/Documents and approval by the HOD concerned, the Course(s) and equivalent Credits shall have forwarded to the COE for processing of results of the concerned Academic Term.
- 13.3.8 The credit equivalence of the SWAYAM/NPTEL/other approved MOOCs are based on Course durations and/or as recommended by the Course offering body/institute/university. The Credit Equivalence mapped to SWAYAM/ NPTEL approved Courses based on Course durations for transfer of credits is summarized in Table shown below. The Grade will be calculated from the marks received by the Absolute Grading Table 8.11. in the Academic Regulations.

| <b>Table 2: Durations and Credit Equivalence for Transfer of Credits from SWAYAM-NPTEL/ other approved MOOC Courses</b> |                        |                           |
|-------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|
| <b>Sl. No.</b>                                                                                                          | <b>Course Duration</b> | <b>Credit Equivalence</b> |
| 1                                                                                                                       | 4 Weeks                | 1 Credit                  |
| 2                                                                                                                       | 8 Weeks                | 2 Credits                 |
| 3                                                                                                                       | 12 Weeks               | 3 Credits                 |

13.3.9 The maximum permissible number of credits that a student may request for credit transfer from MOOCs shall not exceed 20% of the mandatory minimum credit requirements specified by the concerned Program Regulations and Curriculum for the award of the concerned Degree.

13.3.10 The University shall not reimburse any fees/expense; a student may incur for the SWAYAM/NPTEL/other approved MOOCs.

13.4 The maximum number of credits that can be transferred by a student shall be limited to forty percent (40%) of the mandatory minimum credit requirements specified by the concerned Program Regulations and Curriculum for the award of the concerned Degree. However, the grades obtained in the Courses transferred from other Institutions/MOOCs, as mentioned in this Section (13.0), shall not be included in the calculation of the CGPA.

13.5 **Mandatory Non-Credit Course Completion Requirements:** All mandatory non-credit courses shall be satisfactorily completed by the student as part of the degree requirements. These courses will be evaluated and awarded letter grades based on the following criteria:

S (Satisfactorily Completed): Awarded when the student successfully completes all prescribed course requirements.

NC (Not Completed): Awarded when the student fails to meet the prescribed course requirements.

A student receiving an NC grade must reappear for and complete the course in accordance with the guidelines prescribed by the University.

In the case of non-taught and non-credited mandatory courses—where students are advised to undertake learning through MOOC platforms—there shall be a clearly defined Course Catalogue and a corresponding Course Plan. The Course Plan shall outline the assessment components, which will form the basis for evaluation.

## PART B – PROGRAM STRUCTURE

### 14. Structure / Component with Credit Requirements Course Baskets & Minimum Basket wise Credit Requirements

The B.Tech. (Computer Science and Engineering-Cyber Security) Program Structure (2025-2029) totaling 160 credits. Table 3.0 summarizes the type of baskets, number of courses under each basket and the associated credits that are mandatorily required for the completion of the Degree.

| <b>Table 3: B.Tech in Artificial Intelligence and Data Science 2025-2029: Summary of Mandatory Courses and Minimum Credit Contribution from various Baskets</b> |                                                                    |                            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|----------------------------|
| <b>Sl. No.</b>                                                                                                                                                  | <b>Baskets</b>                                                     | <b>Credit Contribution</b> |
| 1                                                                                                                                                               | Humanities and Social Sciences including Management Courses (HSMC) | 10                         |
| 2                                                                                                                                                               | Basic Science Courses (BSC)                                        | 24                         |
| 3                                                                                                                                                               | Engineering Science Courses (ESC)                                  | 22                         |
| 4                                                                                                                                                               | Professional Core Courses (PCC)                                    | 64                         |
| 5                                                                                                                                                               | Project Work (PRW)                                                 | 16                         |
| 6                                                                                                                                                               | Professional Elective Courses (PEC)                                | 18                         |
| 7                                                                                                                                                               | Open Elective Courses (OEC)                                        | 06                         |
| 8                                                                                                                                                               | Mandatory Courses (MAC)*                                           | 0                          |
|                                                                                                                                                                 | <b>Total Credits</b>                                               | <b>160<br/>(Minimum)</b>   |

\* Please refer to Table 3.8, (where the number '8' corresponds to the serial number of the Mandatory course basket.)

In the entire Program, the practical and skill based course component contribute to an extent of approximately 61% out of the total credits of 160 for B.Tech. in Artificial Intelligence and Data Science program of four years' duration.

### 15. Minimum Total Credit Requirements of Award of Degree

As per the AICTE guidelines, a minimum of 160 credits is required for the award of a B.Tech. degree.

### 16. Other Specific Requirements for Award of Degree, if any, as prescribed by the Statutory Bodies,

- 16.1 The award of the Degree shall be recommended by the Board of Examinations and approved by the Academic Council and Board of Management of the University.
- 16.2 A student shall be declared to be eligible for the award of the concerned Degree if she/he:

- a. Fulfilled the Minimum Credit Requirements and the Minimum Credits requirements under various baskets;
- b. Secure a minimum CGPA of 4.50 in the concerned Program at the end of the Semester/Academic Term in which she/he completes all the requirements for the award of the Degree as specified in Sub-Clause 19.2.1**Error! Reference source not found.** of Academic Regulations;
- c. No dues to the University, Departments, Hostels, Library, and any other such Centers/ Departments of the University; and
- d. No disciplinary action is pending against her/him.

## PART-C: CURRICULUM STRUCTURE

**17. Curriculum Structure – Basket Wise Course List (not Semester Wise)**  
**List of Courses Tabled – aligned to the Program Structure**  
**(Course Code, Course Name, Credit Structure (LTPC), Contact Hours, Course Basket, Type of Skills etc., as applicable).**

| Type of Skill         |
|-----------------------|
| F - Foundation        |
| S - Skill Development |
| EM – Employability    |
| EN – Entrepreneurship |
| SS-Soft Skills        |
| AT-Aptitude Training  |

| Course Caters to                          |
|-------------------------------------------|
| GS - Gender Sensitization                 |
| ES - Environment and sustainability       |
| HP - Human values and Professional Ethics |

| Baskets                                                                     |
|-----------------------------------------------------------------------------|
| HSMC - Humanities and Social Sciences (including Management courses) (HSMC) |
| BSC - Basic Science Courses                                                 |
| ESC - Engineering Science Courses                                           |
| PCC - Professional Core Course                                              |
| PEC - Professional Elective Courses                                         |
| OEC - Open Elective Courses                                                 |
| EEC - Employment Enhancement Courses                                        |
| MAC - Mandatory Course                                                      |

| <b>Table 3.1</b><br><b>List of Humanities and Social Sciences including Management Courses (HSMC)</b> |             |                               |   |   |   |         |               |               |               |
|-------------------------------------------------------------------------------------------------------|-------------|-------------------------------|---|---|---|---------|---------------|---------------|---------------|
| Sl. No.                                                                                               | Course Code | Course Name                   | L | T | P | Credits | Contact Hours | Type of Skill | Pre-requisite |
| 1                                                                                                     | ENG1030     | Fundamentals of Communication | 1 | 0 | 2 | 2       | 3             | S             | Nil           |
| 2                                                                                                     | ENG2030     | Communication in Practice     | 1 | 0 | 2 | 2       | 3             | S             | Nil           |
| 3                                                                                                     | FIN1002     | Essentials of Finance         | 3 | 0 | 0 | 3       | 3             | S             | Nil           |
| 4                                                                                                     | APT4005     | Aptitude for Employability    | 0 | 0 | 2 | 1       | 2             | AT            | Nil           |
| 5                                                                                                     | PPS3018     | Preparedness for Interview    | 0 | 0 | 2 | 1       | 2             | SS            | Nil           |
| <b>Total</b>                                                                                          |             |                               | 5 | 0 | 8 | 9       | 13            |               |               |

| Table 3.2: List of Basic Science Courses (BSC) |             |                                                                 |           |          |          |           |               |               |               |
|------------------------------------------------|-------------|-----------------------------------------------------------------|-----------|----------|----------|-----------|---------------|---------------|---------------|
| Sl. No.                                        | Course Code | Course Name                                                     | L         | T        | P        | Credits   | Contact Hours | Type of Skill | Pre-requisite |
| 1                                              | MAT2301     | Calculus and Differential Equations                             | 3         | 1        | 0        | 4         | 4             | F             | Nil           |
| 2                                              | PHY2501     | Optoelectronics and Quantum Physics                             | 3         | 0        | 0        | 3         | 3             | F             | Nil           |
| 3                                              | PHY2504     | Optoelectronics and Quantum Physics Lab                         | 0         | 0        | 2        | 1         | 2             | F             | Nil           |
| 4                                              | MAT1212     | Mathematical foundations for Machine Learning and Data Analysis | 3         | 1        | 0        | 4         | 4             | F             | Nil           |
| 5                                              | CHE2501     | Chemistry of Smart Materials                                    | 3         | 0        | 0        | 3         | 3             | S             | Nil           |
| 6                                              | CHE2502     | Chemistry of Smart Materials Lab                                | 0         | 0        | 2        | 1         | 2             | S             | Nil           |
| 7                                              | MAT2311     | Vector Calculus, Numerical Methods and Sampling Distributions   | 3         | 1        | 0        | 4         | 4             | EM            | Nil           |
| 8                                              | MAT2321     | Discrete Mathematical Structures                                | 3         | 1        | 0        | 4         | 4             | F             | Nil           |
| <b>Total</b>                                   |             |                                                                 | <b>18</b> | <b>4</b> | <b>4</b> | <b>24</b> | <b>26</b>     |               |               |

| Table 3.3: List of Engineering Science Courses (ESC) |             |                                                          |           |          |           |           |               |               |               |
|------------------------------------------------------|-------------|----------------------------------------------------------|-----------|----------|-----------|-----------|---------------|---------------|---------------|
| Sl. No.                                              | Course Code | Course Name                                              | L         | T        | P         | Credits   | Contact Hours | Type of Skill | Pre-requisite |
| 1                                                    | MEC1006     | Engineering Graphics                                     | 2         | 0        | 0         | 2         | 2             | S             | Nil           |
| 2                                                    | CSS1500     | Computational Thinking using Python                      | 2         | 0        | 2         | 3         | 4             | S             | Nil           |
| 3                                                    | ECE2022     | Digital Design                                           | 2         | 0        | 0         | 2         | 2             | F/S           | Nil           |
| 4                                                    | ECE2052     | Digital Design Lab                                       | 0         | 0        | 2         | 1         | 2             | F/S           | Nil           |
| 5                                                    | CIV1200     | Foundations of Integrated Engineering                    | 2         | 0        | 0         | 2         | 2             | S             | Nil           |
| 6                                                    | EEE1200     | Basics of Electrical and Electronics Engineering         | 3         | 0        | 0         | 3         | 3             | F/S           | Nil           |
| 7                                                    | EEE1251     | Basics of Electrical and Electronics Engineering Labtory | 0         | 0        | 2         | 1         | 2             | F/S           | Nil           |
| 8                                                    | ECE1512     | Design Thinking in Practice                              | 2         | 0        | 2         | 3         | 3             | S/EM          | Nil           |
| 9                                                    | CSS2264     | Essentials of AI                                         | 3         | 0        | 0         | 3         | 3             | S/EM          | Nil           |
| 10                                                   | CSS2265     | Essentials of AI Lab                                     | 0         | 0        | 2         | 1         | 2             | S/EM          | Nil           |
| 11                                                   | CSS2274     | Competitive Programming and Problem Solving              | 0         | 0        | 4         | 2         | 4             | S/EM          | Nil           |
| <b>Total</b>                                         |             |                                                          | <b>15</b> | <b>0</b> | <b>14</b> | <b>22</b> |               |               |               |

| Table 3.4: List of Program Core Courses (PCC) |             |                                                   |   |   |   |   |               |                       |                               |  |
|-----------------------------------------------|-------------|---------------------------------------------------|---|---|---|---|---------------|-----------------------|-------------------------------|--|
| S. No                                         | Course Code | Course Name                                       | L | T | P | C | Contact Hours | Type of Skills/ Focus | Pre-requisites/ Co-requisites |  |
| 1                                             | CSS2200     | Problem Solving using C                           | 2 | 0 | 0 | 2 | 2             | S                     | Nil                           |  |
| 2                                             | CSS2201     | Problem Solving using C Lab                       | 0 | 0 | 4 | 2 | 4             | S/EM                  | Nil                           |  |
| 3                                             | CSS2251     | Data Communication and Computer Networks          | 3 | 0 | 0 | 3 | 3             | S                     | Nil                           |  |
| 4                                             | CSS2252     | Data Communication and Computer Networks Lab      | 0 | 0 | 2 | 1 | 2             | S                     | Nil                           |  |
| 5                                             | CSS2278     | Data Structures and Analysis of Algorithms        | 3 | 0 | 0 | 3 | 3             | S                     | Nil                           |  |
| 6                                             | CSS2288     | Data Structures and Analysis of Algorithms Lab    | 0 | 0 | 2 | 1 | 2             | S/EM                  | Nil                           |  |
| 6                                             | CSD1712     | Statistical Foundations of Data Science           | 3 | 0 | 0 | 3 | 3             | S                     | MAT2402                       |  |
| 7                                             | CSD1713     | Statistical Foundations of Data Science Lab       | 0 | 0 | 2 | 1 | 2             | S                     | MAT2402                       |  |
| 8                                             | CSS2255     | Object Oriented Programming Using Java            | 3 | 0 | 0 | 3 | 3             | S/EM                  | Nil                           |  |
| 9                                             | CSS2256     | Object Oriented Programming Using Java Lab        | 0 | 0 | 2 | 1 | 2             | S/EM                  | Nil                           |  |
| 10                                            | CSD2002     | Introduction to Data Science                      | 3 | 0 | 0 | 3 | 3             | F                     | NIL                           |  |
| 11                                            | CSS2258     | Web Technologies                                  | 3 | 0 | 0 | 3 | 3             | S/EM                  | Nil                           |  |
| 12                                            | CSS2259     | Web Technologies Lab                              | 0 | 0 | 2 | 1 | 2             | S/EM                  | Nil                           |  |
| 13                                            | CSS2260     | Database Management Systems                       | 3 | 0 | 0 | 3 | 3             | S                     | Nil                           |  |
| 14                                            | CSS2261     | Database Management Systems Lab                   | 0 | 0 | 2 | 1 | 2             | S                     | Nil                           |  |
| 15                                            | ADS2107     | Exploratory Data Analysis                         | 3 | 0 | 0 | 3 | 3             | S                     | Nil                           |  |
| 16                                            | ADS2008     | Exploratory Data Analysis Lab                     | 0 | 0 | 2 | 1 | 2             | S                     | Nil                           |  |
| 17                                            | ADS2009     | Big Data Technologies                             | 3 | 0 | 0 | 3 | 3             | S                     | Nil                           |  |
| 18                                            | CSD2004     | Cloud Computing for Data Science                  | 2 | 0 | 0 | 2 | 2             | S                     | Nil                           |  |
| 18                                            | CSD2005     | Cloud Computing for Data Science Lab              | 0 | 0 | 2 | 1 | 2             | S                     | Nil                           |  |
| 19                                            | CSD2021     | Machine Learning for Intelligent Data Science     | 3 | 0 | 0 | 3 | 3             | S                     | Nil                           |  |
| 20                                            | CSD2024     | Machine Learning for Intelligent Data Science Lab | 0 | 0 | 2 | 1 | 2             | S                     | Nil                           |  |
| 21                                            | CSS2269     | Operating Systems                                 | 3 | 0 | 0 | 3 | 3             | S                     | Nil                           |  |
| 22                                            | CSD2009     | Data Handling and Visualization                   | 2 | 0 | 0 | 2 | 2             | S                     | Nil                           |  |

|                             |         |                                                                          |   |   |   |   |           |      |         |
|-----------------------------|---------|--------------------------------------------------------------------------|---|---|---|---|-----------|------|---------|
| 23                          | CSD2010 | Data Handling and Visualization Lab                                      | 0 | 0 | 4 | 2 | 4         | S    | Nil     |
| 24                          | CSS2271 | Software Design and Development                                          | 3 | 0 | 0 | 3 | 3         | S    | Nil     |
| 25                          | ADS2505 | Deep Learning and Reinforcement Learning Techniques for Data Science     | 3 | 0 | 0 | 3 | 3         | S    | CSE2064 |
| 26                          | ADS2506 | Deep Learning and Reinforcement Learning Techniques for Data Science Lab | 0 | 0 | 4 | 2 | 4         | S    | CSE2064 |
| 27                          | ADS2503 | Natural Language Understanding and Analytics                             | 3 | 0 | 0 | 3 | 3         | S/EM | CSE1500 |
| 28                          | ADS2504 | Natural Language Understanding and Analytics Lab                         | 0 | 0 | 2 | 1 | 2         | S/EM | CSE1500 |
| <b>Total No. of Credits</b> |         |                                                                          |   |   |   |   | <b>64</b> |      |         |

**Table 3.5: List of course in Project Work basket (PRW)**

| Sl. No.      | Course Code | Course Name      | L        | T        | P        | C         | Contact Hours | Type of Skill | Pre-requisite |
|--------------|-------------|------------------|----------|----------|----------|-----------|---------------|---------------|---------------|
| 1            | CSS7000     | Internship       | 0        | 0        | 0        | 2         | 0             | S/EM          | --            |
| 2            | CSS7100     | Mini Project     | 0        | 0        | 0        | 4         | 0             | S/EM          | --            |
| 3            | CSS7300     | Capstone Project | 0        | 0        | 0        | 10        | 0             | S/EM          | --            |
| <b>Total</b> |             |                  | <b>0</b> | <b>0</b> | <b>0</b> | <b>16</b> | <b>0</b>      |               |               |

**Table 3.6 : List of Mandatory Courses (MAC)**

| S.No                        | Course Code | Course Name                       | L | T | P | C        |
|-----------------------------|-------------|-----------------------------------|---|---|---|----------|
| 1                           | CHE7601     | Environmental Studies             | 1 | 0 | 0 | 0        |
| 2                           | LAW7601     | Indian Constitution               | 1 | 0 | 0 | 0        |
| 3                           | CIV7601     | Universal Human Values and Ethics | 1 | 0 | 0 | 0        |
| 4                           | PPS1025     | Industry Readiness Program - I    | 0 | 0 | 2 | 0        |
| 5                           | PPS1026     | Industry Readiness Program - II   | 0 | 0 | 2 | 0        |
| 6                           | APT4002     | Introduction to Aptitude          | 0 | 0 | 2 | 0        |
| 7                           | APT4004     | Aptitude Training - Intermediate  | 0 | 0 | 2 | 0        |
| 8                           | APT4006     | Logical and Critical Thinking     | 0 | 0 | 2 | 0        |
| <b>Total No. of Credits</b> |             |                                   |   |   |   | <b>0</b> |

#### **18. Practical / Skill based Courses – Internships / Thesis / Dissertation / Capstone Project Work / Portfolio / Mini project**

Practical / Skill based Courses like internship, project work, capstone project, research project / dissertation, and such similar courses, where the pedagogy does not lend itself to a typical L-T-P-C Structure as defined in Clause 5.1 of the Academic Regulations, are simply assigned the number of Credits based on the quantum of work / effort required to fulfill the learning objectives and outcomes prescribed for the concerned Courses. Such courses are referred to as Non-Teaching Credit Courses (NTCC). These Courses are designed to provide students with hands-on experience and skills essential for their professional development. These courses aim to equip students with abilities in problem identification, root cause

analysis, problem-solving, innovation, and design thinking through industry exposure and project-based learning. The expected outcomes are first level proficiency in problem solving and design thinking skills to better equip B.Tech. graduates for their professional careers. The method of evaluation and grading for the Practical / Skill based Courses shall be prescribed and approved by the concerned Departmental Academic Committee (refer Annexure A of the Academic Regulations). The same shall be prescribed in the Course Handout.

### **18.1 Internship / In-plant Training / Skill-based Program / International Immersion (IM) / Recognition of Prior Learning (RPL)**

A student may undergo an Internship / In-plant Training / Skill-based Program / IM/ RPL for a period minimum 04 weeks in an industry / company, government bodies, academic / research institution or recognized online platforms offering certified skill-based programs during the semester break between 4<sup>th</sup> and 5<sup>th</sup> semesters, subject to the following conditions:

- 18.1.1 The Internship / In-plant Training / Skill-based Program / IM/ RPL shall be conducted in accordance with the Internship Policy prescribed by the University from time to time.
- 18.1.2 Internship: student shall undergo internship, either in industry / company, academic / research organizations, government bodies, or international institutions. The objective is to provide practical exposure, industry insights, and real-world experience relevant to the student's field of study.
- 18.1.3 In-plant Training: student shall undergo training / industrial exposure program aimed at providing with practical insights into real-world working environments. The training may be conducted by industries / companies on-campus or through student visits to industries / companies, government bodies / institutions, or technical organizations.
- 18.1.4 Skill-based Program: student shall undergo a certified skill-based program of 30 hours / 04 weeks. Skill-based program should cater to Skill-Enhancement, Practical Focus, and Career orientation, Complementary to Curriculum or Industry relevant.
- 18.1.5 International Immersion (IM): student shall undergo IM aimed at providing global exposure through collaborations with foreign universities, industries, or research institutions. The International Immersion may include industry visits, expert interactions, and cultural exchange activities, enhancing students' international outlook, communication skills, and professional readiness.
- 18.1.6 Recognition of Prior Learning (RPL): student who shall undergo any formally recognize relevant prior work experience, internships, or project-based learning that meet the internship learning outcomes, thereby allowing students to earn internship credit without repeating equivalent practical training.
- 18.1.7 The number of Internships available for the concerned Academic Term. Further, the available number of Internships / In-plant training / Skill-based Program / IM / RPL shall be awarded to the students by the University on the basis of merit using the CGPA secured by the student and as per the selection criteria. Provided further, the student fulfils the criteria, as applicable, specified by the industry / company, government bodies, academic / research or through certified courses.
- 18.1.8 A student may opt for Internship / In-plant Training / IM / RPL in an industry / company, government bodies / academic / research institution, international bodies of her / his choice, subject to the condition that the concerned student takes the responsibility to arrange the

Internship / In-plant Training/ IM / RPL on her / his own. Provided further, that the industry / company, government bodies, academic / research institution national or international offering such Internship / Training confirms to the University that the Internship shall be conducted in accordance with the Program Regulations and Internship Policy of the University / Rubrics.

- 18.1.9 A student undergoing RPL must submit an application with supporting documents such as experience letters, project reports, employer feedback, certifications, a self-reflection report etc. Application must be submitted before the commencement of the internship semester.
- 18.1.10 A student selected for an Internship / In-plant Training / Skill-based Program / IM / RPL in an industry / company, government bodies, academic / research institution shall adhere to all the rules and guidelines prescribed in the Internship Policy of the University.

The performance will be assessed and grades awarded as per the university's academic grading policy. It may be included as a non-GPA course (Grade-based Satisfactorily Completed/Not Completed). The student must secure a minimum of 50% of the total marks to be declared as having successfully completed the course.

## **18.2 MINI Project**

A student may opt to do a Project Work for a period of 4-6 weeks in an Industry / Company or academic / research institution or the University Department(s) as an equivalence of Internship during the Semester Break between 4<sup>th</sup> and 5<sup>th</sup> Semesters or 6<sup>th</sup> and 7<sup>th</sup> Semesters or during the 5<sup>th</sup> / 6<sup>th</sup> / 7<sup>th</sup> Semester as applicable, subject to the following conditions.

- 18.2.1 The Project Work shall be approved by the concerned HOD and be carried out under the guidance of a faculty member.
- 18.2.2 The student may do the project work in an Industry / Company or academic / research institution of her / his choice subject to the above mentioned condition (Sub-Clause 18.2.1). Provided further, that the Industry / Company or academic / research institution offering such project work confirms to the University that the project work will be conducted in accordance with the Program Regulations and requirements of the University.

## **18.3 Capstone Project**

A student may undergo a Capstone Project for a period of 12-14 weeks in an industry / company or academic / research institution in the 7<sup>th</sup> / 8<sup>th</sup> Semester as applicable, subject to the following conditions:

- 18.3.1 The Capstone Project shall be conducted in accordance with the Capstone Project Policy prescribed by the University from time to time.
- 18.3.2 The selection criteria (minimum CGPA, pass in all Courses as on date, and any other qualifying criteria) as applicable / stipulated by the concerned Industry / Company or academic / research institution for award of the Capstone Project to a student;
- 18.3.3 The number of Capstone Project available for the concerned Academic Term. Further, the available number of Capstone Project shall be awarded to the students by the University on the basis of merit using the CGPA secured by the student. Provided further, the student fulfils the criteria, as applicable, specified by the Industry / Company or academic / research institution providing the Capstone Project, as stated in Sub-Clause 18.3.2 above.
- 18.3.4 A student may opt for Capstone Project in an Industry / Company or academic / research institution of her / his choice, subject to the condition that the concerned

student takes the responsibility to arrange the I Capstone Project on her / his own. Provided further, that the Industry / Company or academic / research institution offering such Capstone Project confirms to the University that the Capstone Project shall be conducted in accordance with the Program Regulations and the Capstone Project Policy of the University.

- 18.3.5 A student selected for a Capstone Project in an industry / company or academic / research institution shall adhere to all the rules and guidelines prescribed in the Capstone Project Policy of the University.

#### **18.4 Research Project / Dissertation**

A student may opt to do a Research Project / Dissertation for a period of 12-14 weeks in an Industry / Company or academic / research institution or the University Department(s) as an equivalence of Capstone Project, subject to the following conditions:

- 18.4.1 The Research Project / Dissertation shall be approved by the concerned HOD and be carried out under the guidance of a faculty member.

The student may do the Research Project / Dissertation in an Industry / Company or academic / research institution of her / his choice subject to the above mentioned condition (Sub-Clause 18.4.4). Provided further, that the Industry / Company or academic / research institution offering such Research Project / Dissertation confirms to the University that the Research Project / Dissertation work will be conducted in accordance with the Program Regulations and requirements of the University.

#### **19. List of Elective Courses under various Specializations / Stream Basket**

| Type of Skill                                                                                                                    | Course Caters to                                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| F - Foundation<br>S - Skill Development<br>EM – Employability<br>EN – Entrepreneurship<br>SS-Soft Skills<br>AT-Aptitude Training | GS - Gender Sensitization<br>ES - Environment and sustainability<br>HP - Human values and Professional Ethics |

**Table 3.7: Professional Electives Courses/Specialization Tracks - Minimum of 12 credits is to be earned by the student in a particular track and overall 18 credits.**

| Specialization Track 1: Advanced Artificial Intelligence Track |         |                                         |   |   |   |   |  |      |  |  |  |
|----------------------------------------------------------------|---------|-----------------------------------------|---|---|---|---|--|------|--|--|--|
| 1                                                              | ADS3400 | Advanced Machine Learning               | 2 | 0 | 2 | 3 |  | S/EM |  |  |  |
| 2                                                              | ADS3401 | Deep Reinforcement Learning             | 2 | 0 | 2 | 3 |  | S/EM |  |  |  |
| 3                                                              | ADS3402 | Generative AI and Large Language Models | 2 | 0 | 2 | 3 |  | S/EM |  |  |  |

|                                                                        |         |                                                                        |   |   |   |   |   |       |         |
|------------------------------------------------------------------------|---------|------------------------------------------------------------------------|---|---|---|---|---|-------|---------|
| 4                                                                      | ADS3403 | Knowledge Representation and Reasoning                                 | 2 | 0 | 2 | 3 |   | S/EM  |         |
| 5                                                                      | ADS3404 | Multi-Agent Systems                                                    | 2 | 0 | 2 | 3 |   | S/EM  |         |
| 6                                                                      | ADS3400 | Explainable AI                                                         | 2 | 0 | 2 | 3 |   | S/EM  |         |
| Specialization Track 2: Data Engineering and Big Data Analytics Track  |         |                                                                        |   |   |   |   |   |       |         |
| 1                                                                      | ADS3405 | Big Data Analytics                                                     | 2 | 0 | 2 | 3 |   | S/ EM | CSS2264 |
| 2                                                                      | ADS3406 | Data Warehousing and Data Mining                                       | 2 | 0 | 2 | 3 |   | S/ EM | CSS2264 |
| 3                                                                      | ADS3407 | Distributed Data Processing using Hadoop and Spark                     | 2 | 0 | 2 | 3 |   | S/ EM | CSS2264 |
| 4                                                                      | ADS3408 | Data Engineering and ETL Pipelines                                     | 2 | 0 | 2 | 3 |   | S/ EM | CSS2264 |
| 5                                                                      | ADS3409 | Cloud-Based Data Analytics                                             | 2 | 0 | 2 | 3 |   | S/ EM | CSS2264 |
| 6                                                                      | ADS3410 | Real-Time Stream Data Analytics                                        | 2 | 0 | 2 | 3 |   | S/ EM | CSS2264 |
| Specialization Track 3: Data-driven business strategies and analytics. |         |                                                                        |   |   |   |   |   |       |         |
| 1                                                                      | ADS3411 | Business Intelligence and Analytics                                    | 2 | 0 | 2 | 3 |   | S/ EM | CSS2264 |
| 2                                                                      | ADS3412 | Predictive Analytics                                                   | 2 | 0 | 2 | 3 |   | S/ EM | CSS2264 |
| 3                                                                      | ADS3413 | Financial Data Analytics                                               | 2 | 0 | 2 | 3 |   | S/ EM | CSS2264 |
| 4                                                                      | ADS3414 | Marketing and Customer Analytics                                       | 2 | 0 | 2 | 3 |   | S/ EM | CSS2264 |
| 5                                                                      | ADS3415 | Data Visualization and Storytelling                                    | 2 | 0 | 2 | 3 |   | S/ EM | CSS2264 |
| 6                                                                      | ADS3416 | Decision Support Systems                                               | 2 | 0 | 2 | 3 |   | S/ EM | CSS2264 |
| Track - 4 Special Track                                                |         |                                                                        |   |   |   |   |   |       |         |
| 1                                                                      | CSSXXXX | Introduction to NVIDIA Accelerated Computing and AI                    | 2 | 0 | 2 | 3 | 3 | S/ EM |         |
| 2                                                                      | CSSXXXX | NVIDIA Applied Artificial Intelligence and Generative AI               | 2 | 0 | 2 | 3 | 3 | S/ EM |         |
| 3                                                                      | CSSXXXX | Advanced AI Systems and Generative Intelligence using NVIDIA Platforms | 2 | 0 | 2 | 3 | 3 | S/ EM |         |
| 4                                                                      | CSS3426 | Front End Full Stack Development                                       | 2 | 0 | 2 | 3 | 3 | S/ EM | CSE2258 |

|   |         |                             |   |   |   |   |   |       |         |
|---|---------|-----------------------------|---|---|---|---|---|-------|---------|
| 5 | CSS3427 | Java Full Stack Development | 2 | 0 | 2 | 3 | 3 | S/ EM | CSE2258 |
| 6 | CSS3428 | .Net Full Stack Development | 2 | 0 | 2 | 3 | 3 | S/ EM | CSE2258 |

| Track 5: Industrial Track |         |                                                                             |   |   |   |    |    |      |  |
|---------------------------|---------|-----------------------------------------------------------------------------|---|---|---|----|----|------|--|
| 1                         | CSSXXXX | Advanced Statistical Computing and Applied Inference Systems                | 2 | 0 | 2 | 3  | 3  | S/EM |  |
| 2                         | CSSXXXX | Predictive Systems Engineering for Structured Data                          | 2 | 0 | 2 | 3  | 3  | S/EM |  |
| 3                         | CSSXXXX | Data Engineering Pipelines and Visual Analytics for Strategic Communication | 2 | 0 | 2 | 3  | 3  | S/EM |  |
| 4                         | CSSXXXX | Distributed Data Systems and High-Throughput Analytics                      | 2 | 0 | 2 | 3  | 3  | S/EM |  |
| 5                         | CSSXXXX | Multidimensional Data Modeling and Representation Learning                  | 2 | 0 | 2 | 3  | 3  | S/EM |  |
| 6                         | CSSXXXX | Operational Analytics and Computational Optimization Techniques             | 2 | 0 | 2 | 3  | 3  | S/EM |  |
| 7                         | CSSXXXX | Mini Project/Hackathon - Data Innovation Challenge                          | 0 | 0 | 0 | 4  | 4  |      |  |
| 8                         | CSSXXXX | Capstone Project - Intelligent Data Product Design and Deployment           | 0 | 0 | 0 | 10 | 10 |      |  |

| Track 6: Infosys Springboard courses |                                                         |  |
|--------------------------------------|---------------------------------------------------------|--|
| ADS3500                              | Machine Learning & Data science for Beginners in Python |  |
| ADS3501                              | From Zero to Pro Data Science & AI Advanced Full Course |  |
| Track 7: Nasscom courses             |                                                         |  |
| ADS4500                              | Google Cloud-Generative AI                              |  |
| ADS4501                              | Salesforce AI and Data Cloud Master                     |  |

## 20. List of Open Electives to be offered by the School / Department (Separately for ODD and EVEN Semesters.

| Type of Skill         |
|-----------------------|
| F - Foundation        |
| S - Skill Development |
| EM – Employability    |
| EN – Entrepreneurship |

| Course Caters to                          |
|-------------------------------------------|
| GS - Gender Sensitization                 |
| ES - Environment and sustainability       |
| HP - Human values and Professional Ethics |

| Baskets                                                                     |
|-----------------------------------------------------------------------------|
| HSMC - Humanities and Social Sciences (including Management courses) (HSMC) |
| BSC - Basic Science Courses                                                 |
| ESC - Engineering Science Courses                                           |
| PCC - Professional Core Course                                              |
| PEC - Professional Elective Courses                                         |
| OEC - Open Elective Courses                                                 |
| EEC - Employment Enhancement Courses                                        |
| MAC - Mandatory Course                                                      |

**Table 3.8: Open Elective Courses Baskets: Minimum Credits to be earned from this Basket is 06**

| Course Code                     | Course Name                                 | L | T | P | C | Type of Skill/ Focus | Course Caters to | Pre-requisite s/ Co-requisite s | Anti-requisite s | Future Courses that need this as a Prerequisite |
|---------------------------------|---------------------------------------------|---|---|---|---|----------------------|------------------|---------------------------------|------------------|-------------------------------------------------|
| <b>Chemistry Basket</b>         |                                             |   |   |   |   |                      |                  |                                 |                  |                                                 |
| CHE1003                         | Fundamentals of Sensors                     | 3 | 0 | 0 | 3 | S                    | ES               | -                               | -                | -                                               |
| CHE1004                         | Smart materials for IOT                     | 3 | 0 | 0 | 3 | S                    | ES               | -                               | -                | -                                               |
| CHE1005                         | Computational Chemistry                     | 2 | 0 | 0 | 2 | S                    | ES               | -                               | -                | -                                               |
| CHE1006                         | Introduction to Nano technology             | 3 | 0 | 0 | 3 | S                    | ES               | -                               | -                | -                                               |
| CHE1007                         | Biodegradable electronics                   | 2 | 0 | 0 | 2 | S                    | ES               | -                               | -                | -                                               |
| CHE1008                         | Energy and Sustainability                   | 2 | 0 | 0 | 2 | S                    | ES               | -                               | -                | -                                               |
| CHE1009                         | 3D printing with Polymers                   | 2 | 0 | 0 | 2 | S                    | ES               | -                               | -                | -                                               |
| CHE1010                         | Bioinformatics and Healthcare IT            | 2 | 0 | 0 | 2 | S                    | ES               | -                               | -                | -                                               |
| CHE1011                         | Chemical and Petrochemical catalysts        | 3 | 0 | 0 | 3 | S                    | ES               | -                               | -                | -                                               |
| CHE1012                         | Introduction to Composite materials         | 2 | 0 | 0 | 2 | S                    | ES               | -                               | -                | -                                               |
| CHE1013                         | Chemistry for Engineers                     | 3 | 0 | 0 | 3 | S                    | ES               | -                               | -                | -                                               |
| CHE1014                         | Surface and Coatings technology             | 3 | 0 | 0 | 3 | S                    | ES               | -                               | -                | -                                               |
| CHE1015                         | Waste to Fuels                              | 2 | 0 | 0 | 2 | S                    | ES               | -                               | -                | -                                               |
| CHE1016                         | Forensic Science                            | 3 | 0 | 0 | 3 | S                    | ES               | -                               | -                | -                                               |
| <b>Civil Engineering Basket</b> |                                             |   |   |   |   |                      |                  |                                 |                  |                                                 |
| CIV1001                         | Disaster mitigation and management          | 3 | 0 | 0 | 3 | S                    | -                | -                               | -                | -                                               |
| CIV1002                         | Environment Science and Disaster Management | 3 | 0 | 0 | 3 | FC                   | -                | -                               | -                | -                                               |
| CIV2001                         | Sustainability Concepts in Engineering      | 3 | 0 | 0 | 3 | S                    | -                | -                               | -                | -                                               |
| CIV2002                         | Occupational Health and Safety              | 3 | 0 | 0 | 3 | S                    | -                | -                               | -                | -                                               |

|                                                                          |                                           |   |   |   |   |          |       |   |   |   |
|--------------------------------------------------------------------------|-------------------------------------------|---|---|---|---|----------|-------|---|---|---|
| CIV2003                                                                  | Sustainable Materials and Green Buildings | 3 | 0 | 0 | 3 | EM       | -     | - | - | - |
| CIV2004                                                                  | Integrated Project Management             | 3 | 0 | 0 | 3 | EN       | -     | - | - | - |
| CIV2005                                                                  | Environmental Impact Assessment           | 3 | 0 | 0 | 3 | EN       | -     | - | - | - |
| CIV2006                                                                  | Infrastructure Systems for Smart Cities   | 3 | 0 | 0 | 3 | EN       | -     | - | - | - |
| CIV2044                                                                  | Geospatial Applications for Engineers     | 2 | 0 | 2 | 3 | EM       | -     | - | - | - |
| CIV2045                                                                  | Environmental Meteorology                 | 3 | 0 | 0 | 3 | S        | -     | - | - | - |
| CIV3046                                                                  | Project Problem Based Learning            | 3 | 0 | 0 | 3 | S        | -     | - | - | - |
| CIV3059                                                                  | Sustainability for Professional Practice  | 3 | 0 | 0 | 3 | EN       | -     | - | - | - |
| <b>Commerce Basket</b>                                                   |                                           |   |   |   |   |          |       |   |   |   |
| COM2001                                                                  | Introduction to Human Resource Management | 2 | 0 | 0 | 2 | F        | HP/GS | - | - | - |
| COM2002                                                                  | Finance for Non Finance                   | 2 | 0 | 0 | 2 | S        | -     | - | - | - |
| COM2003                                                                  | Contemporary Management                   | 2 | 0 | 0 | 2 | F        | -     | - | - | - |
| COM2004                                                                  | Introduction to Banking                   | 2 | 0 | 0 | 2 | F        | -     | - | - | - |
| COM2005                                                                  | Introduction to Insurance                 | 2 | 0 | 0 | 2 | F        | -     | - | - | - |
| COM2006                                                                  | Fundamentals of Management                | 2 | 0 | 0 | 2 | F        | -     | - | - | - |
| COM2007                                                                  | Basics of Accounting                      | 3 | 0 | 0 | 3 | F        | -     | - | - | - |
| <b>Computer Science Basket</b>                                           |                                           |   |   |   |   |          |       |   |   |   |
| <b>(not to be offered for Computer Science and Engineering students)</b> |                                           |   |   |   |   |          |       |   |   |   |
| CSS2002                                                                  | Programming in Java                       | 2 | 0 | 2 | 3 | S/EM     | -     | - | - | - |
| CSS2003                                                                  | Social Network Analytics                  | 3 | 0 | 0 | 3 | S        | GS    | - | - | - |
| CSS2004                                                                  | Python Application Programming            | 2 | 0 | 2 | 3 | S/ EM    | -     | - | - | - |
| CSS2005                                                                  | Web design fundamentals                   | 2 | 0 | 2 | 3 | S/ EM/EN | -     | - | - | - |
| <b>Design Basket</b>                                                     |                                           |   |   |   |   |          |       |   |   |   |
| DES1001                                                                  | Sketching and Painting                    | 0 | 0 | 2 | 1 | S        | -     | - | - | - |

|                                             |                                            |   |   |   |   |   |            |   |   |   |
|---------------------------------------------|--------------------------------------------|---|---|---|---|---|------------|---|---|---|
| DES1002                                     | Innovation and Creativity                  | 2 | 0 | 0 | 2 | F | -          | - | - | - |
| DES1121                                     | Introduction to UX design                  | 1 | 0 | 2 | 2 | S | -          | - | - | - |
| DES1122                                     | Introduction to Jewellery Making           | 1 | 0 | 2 | 2 | S | -          | - | - | - |
| DES1124                                     | Spatial Stories                            | 1 | 0 | 2 | 2 | S | -          | - | - | - |
| DES1125                                     | Polymer Clay                               | 1 | 0 | 2 | 2 | S | -          | - | - | - |
| DES2001                                     | Design Thinking                            | 3 | 0 | 0 | 3 | S | -          | - | - | - |
| DES1003                                     | Servicability of Fashion Products          | 1 | 0 | 2 | 2 | F | ES         | - | - | - |
| DES1004                                     | Choices in Virtual Fashion                 | 1 | 0 | 2 | 2 | F | ES, GS, HP | - | - | - |
| DES1005                                     | Fashion Lifestyle and Product Diversity    | 1 | 0 | 2 | 2 | F | ES, GS, HP | - | - | - |
| DES1006                                     | Colour in Everyday Life                    | 1 | 0 | 2 | 2 | F | ES         | - | - | - |
| DES2080                                     | Art of Design Language                     | 3 | 0 | 0 | 3 | S | -          | - | - | - |
| DES2081                                     | Brand Building in Design                   | 3 | 0 | 0 | 3 | S | -          | - | - | - |
| DES2085                                     | Web Design Techniques                      | 3 | 0 | 0 | 3 | S | -          | - | - | - |
| DES2089                                     | 3D Modeling for Professionals              | 1 | 0 | 4 | 3 | S | -          | - | - | - |
| DES2090                                     | Creative Thinking for Professionals        | 3 | 0 | 0 | 3 | S | -          | - | - | - |
| DES2091                                     | Idea Formulation                           | 3 | 0 | 0 | 3 | S | -          | - | - | - |
| <b>Electrical and Electronics Basket</b>    |                                            |   |   |   |   |   |            |   |   |   |
| EEE1002                                     | IoT based Smart Building Technology        | 3 | 0 | 0 | 3 | S | -          | - | - | - |
| EEE1003                                     | Basic Circuit Analysis                     | 3 | 0 | 0 | 3 | S | -          | - | - | - |
| EEE1004                                     | Fundamentals of Industrial Automation      | 3 | 0 | 0 | 3 | S | -          | - | - | - |
| EEE1005                                     | Electric Vehicles & Battery Technology     | 3 | 0 | 0 | 3 | S | -          | - | - | - |
| EEE1006                                     | Smart Sensors for Engineering Applications | 3 | 0 | 0 | 3 | S | -          | - | - | - |
| <b>Electronics and Communication Basket</b> |                                            |   |   |   |   |   |            |   |   |   |
| ECE1003                                     | Fundamentals of Electronics                | 3 | 0 | 0 | 3 | F | -          | - | - | - |

|                       |                                                 |   |   |   |   |             |        |   |   |   |
|-----------------------|-------------------------------------------------|---|---|---|---|-------------|--------|---|---|---|
| ECE1004               | Microprocessor based systems                    | 3 | 0 | 0 | 3 | F           | -      | - | - | - |
| ECE3089               | Artificial Neural Networks                      | 3 | 0 | 0 | 3 | S           | -      | - | - | - |
| ECE3097               | Smart Electronics in Agriculture                | 3 | 0 | 0 | 3 | F/EM        | -      | - | - | - |
| ECE3098               | Environment Monitoring Systems                  | 3 | 0 | 0 | 3 | F/EM        | -      | - | - | - |
| ECE3102               | Consumer Electronics                            | 3 | 0 | 0 | 3 | F/EM        | -      | - | - | - |
| ECE3103               | Product Design of Electronic Equipment          | 3 | 0 | 0 | 3 | S/F/EM / EN | -      | - | - | - |
| ECE3106               | Introduction to Data Analytics                  | 3 | 0 | 0 | 3 | F/EM        | -      | - | - | - |
| ECE3107               | Machine Vision for Robotics                     | 3 | 0 | 0 | 3 | F/EM        | -      | - | - | - |
| <b>English Basket</b> |                                                 |   |   |   |   |             |        |   |   |   |
| ENG1008               | Indian Literature                               | 2 | 0 | 0 | 2 | -           | GS/ HP | - | - | - |
| ENG1009               | Reading Advertisement                           | 3 | 0 | 0 | 3 | S           | -      | - | - | - |
| ENG1010               | Verbal Aptitude for Placement                   | 2 | 0 | 2 | 3 | S           | -      | - | - | - |
| ENG1011               | English for Career Development                  | 3 | 0 | 0 | 3 | S           | -      | - | - | - |
| ENG1012               | Gender and Society in India                     | 2 | 0 | 0 | 2 | -           | GS/ HP | - | - | - |
| ENG1013               | Indian English Drama                            | 3 | 0 | 0 | 3 | -           | -      | - | - | - |
| ENG1014               | Logic and Art of Negotiation                    | 2 | 0 | 2 | 3 | -           | -      | - | - | - |
| ENG1015               | Professional Communication Skills for Engineers | 1 | 0 | 0 | 1 | -           | -      | - | - | - |
| <b>DSA Basket</b>     |                                                 |   |   |   |   |             |        |   |   |   |
| DSA2001               | Spirituality for Health                         | 2 | 0 | 0 | 2 | F           | HP     | - | - | - |
| DSA2002               | Yoga for Health                                 | 2 | 0 | 0 | 2 | S           | HP     | - | - | - |
| DSA2003               | Stress Management and Well Being                | 2 | 0 | 0 | 2 | F           | -      | - | - | - |
| <b>Kannada Basket</b> |                                                 |   |   |   |   |             |        |   |   |   |
| KAN1001               | Kali Kannada                                    | 1 | 0 | 0 | 1 | S           | -      | - | - | - |
| KAN1003               | Kannada Kaipidi                                 | 3 | 0 | 0 | 3 | S           | -      | - | - | - |
| KAN2001               | Thili Kannada                                   | 1 | 0 | 0 | 1 | S           | -      | - | - | - |

|                                |                                     |   |   |   |   |   |       |   |   |   |
|--------------------------------|-------------------------------------|---|---|---|---|---|-------|---|---|---|
| KAN2003                        | Pradharshana Kale                   | 1 | 0 | 2 | 2 | S | -     | - | - | - |
| KAN2004                        | Sahithya Vimarshe                   | 2 | 0 | 0 | 2 | S | -     | - | - | - |
| KAN2005                        | Anuvadha Kala Sahithya              | 3 | 0 | 0 | 3 | S | -     | - | - | - |
| KAN2006                        | Vichara Manthana                    | 3 | 0 | 0 | 3 | S | -     | - | - | - |
| KAN2007                        | Katha Sahithya Sampada              | 3 | 0 | 0 | 3 | S | -     | - | - | - |
| KAN2008                        | Ranga Pradarshana Kala              | 3 | 0 | 0 | 3 | S | -     | - | - | - |
| <b>Foreign Language Basket</b> |                                     |   |   |   |   |   |       |   |   |   |
| FRL1004                        | Introduction of French Language     | 2 | 0 | 0 | 2 | S | S     | - | - | - |
| FRL1005                        | Fundamentals of French              | 2 | 0 | 0 | 2 | S | S     | - | - | - |
| FRL1009                        | Mandarin Chinese for Beginners      | 3 | 0 | 0 | 3 | S | S     | - | - | - |
| <b>Law Basket</b>              |                                     |   |   |   |   |   |       |   |   |   |
| LAW1001                        | Introduction to Sociology           | 2 | 0 | 0 | 2 | F | HP    |   | - | - |
| LAW2001                        | Indian Heritage and Culture         | 2 | 0 | 0 | 2 | F | HP/GS |   | - | - |
| LAW2002                        | Introduction to Law of Succession   | 2 | 0 | 0 | 2 | F | HP/GS |   | - | - |
| LAW2003                        | Introduction to Company Law         | 2 | 0 | 0 | 2 | F | HP    |   | - | - |
| LAW2004                        | Introduction to Contracts           | 2 | 0 | 0 | 2 | F | HP    | - | - | - |
| LAW2005                        | Introduction to Copy Rights Law     | 2 | 0 | 0 | 2 | F | HP    | - | - | - |
| LAW2006                        | Introduction to Criminal Law        | 2 | 0 | 0 | 2 | F | HP    | - | - | - |
| LAW2007                        | Introduction to Insurance Law       | 2 | 0 | 0 | 2 | F | HP    | - | - | - |
| LAW2008                        | Introduction to Labour Law          | 2 | 0 | 0 | 2 | F | HP    | - | - | - |
| LAW2009                        | Introduction to Law of Marriages    | 2 | 0 | 0 | 2 | F | HP/GS | - | - | - |
| LAW2010                        | Introduction to Patent Law          | 2 | 0 | 0 | 2 | F | HP    | - | - | - |
| LAW2011                        | Introduction to Personal Income Tax | 2 | 0 | 0 | 2 | F | HP    | - | - | - |
| LAW2012                        | Introduction to Real Estate Law     | 2 | 0 | 0 | 2 | F | HP    | - | - | - |

|                           |                                         |   |   |   |   |           |       |   |         |   |
|---------------------------|-----------------------------------------|---|---|---|---|-----------|-------|---|---------|---|
| LAW2013                   | Introduction to Trademark Law           | 2 | 0 | 0 | 2 | F         | HP    | - | -       | - |
| LAW2014                   | Introduction to Competition Law         | 3 | 0 | 0 | 3 | F         | HP    | - | -       | - |
| LAW2015                   | Cyber Law                               | 3 | 0 | 0 | 3 | F         | HP    | - | -       | - |
| LAW2016                   | Law on Sexual Harrassment               | 2 | 0 | 0 | 2 | F         | HP/GS | - | -       | - |
| LAW2017                   | Media Laws and Ethics                   | 2 | 0 | 0 | 2 | F         | HP/GS | - | -       | - |
| <b>Mathematics Basket</b> |                                         |   |   |   |   |           |       |   |         |   |
| MAT2008                   | Mathematical Reasoning                  | 3 | 0 | 0 | 3 | S         | -     | - | -       | - |
| MAT2014                   | Advanced Business Mathematics           | 3 | 0 | 0 | 3 | S         | -     | - | -       | - |
| MAT2041                   | Functions of Complex Variables          | 3 | 0 | 0 | 3 | S         | -     | - | -       | - |
| MAT2042                   | Probability and Random Processes        | 3 | 0 | 0 | 3 | S         | -     | - | -       | - |
| MAT2043                   | Elements of Number Theory               | 3 | 0 | 0 | 3 | S         | -     | - | -       | - |
| MAT2044                   | Mathematical Modelling and Applications | 3 | 0 | 0 | 3 | S         | -     | - | -       | - |
| <b>Mechanical Basket</b>  |                                         |   |   |   |   |           |       |   |         |   |
| MEC1001                   | Fundamentals of Automobile Engineering  | 3 | 0 | 0 | 3 | F         | -     | - | -       | - |
| MEC1002                   | Introduction to Matlab and Simulink     | 3 | 0 | 0 | 3 | S/EM      | -     | - | -       | - |
| MEC1003                   | Engineering Drawing                     | 1 | 0 | 4 | 3 | S         | -     | - | -       | - |
| MEC2001                   | Renewable Energy Systems                | 3 | 0 | 0 | 3 | F         | ES    | - | -       | - |
| MEC2002                   | Operations Research & Management        | 3 | 0 | 0 | 3 | F         | -     | - | -       | - |
| MEC2003                   | Supply Chain Management                 | 3 | 0 | 0 | 3 | S/ EM/ EN | -     | - | -       | - |
| MEC2004                   | Six Sigma for Professionals             | 3 | 0 | 0 | 3 | S/EM      | -     | - | MEC2008 | - |
| MEC2005                   | Fundamentals of Aerospace Engineering   | 3 | 0 | 0 | 3 | F         | -     | - | -       | - |
| MEC2006                   | Safety Engineering                      | 3 | 0 | 0 | 3 | S/EM      | ES    | - | -       | - |
| MEC2007                   | Additive Manufacturing                  | 3 | 0 | 0 | 3 | F/EM      | -     | - | -       | - |

|                              |                                             |   |   |   |   |         |    |   |     |   |
|------------------------------|---------------------------------------------|---|---|---|---|---------|----|---|-----|---|
| MEC3069                      | Engineering Optimisation                    | 3 | 0 | 0 | 3 | S/EM    | -  | - | -   | - |
| MEC3070                      | Electronics Waste Management                | 3 | 0 | 0 | 3 | F/S     | ES | - | -   | - |
| MEC3071                      | Hybrid Electric Vehicle Design              | 3 | 0 | 0 | 3 | S/EM    | ES | - | -   | - |
| MEC3072                      | Thermal Management of Electronic Appliances | 3 | 0 | 0 | 3 | S/EM    | -  | - | -   | - |
| MEC3200                      | Sustainable Technologies and Practices      | 3 | 0 | 0 | 3 | S/EM    | -  | - | -   | - |
| MEC3201                      | Industry 4.0                                | 3 | 0 | 0 | 3 | S/EM    | -  | - | -   | - |
| <b>Petroleum Basket</b>      |                                             |   |   |   |   |         |    |   |     |   |
| PET1011                      | Energy Industry Dynamics                    | 3 | 0 | 0 | 3 | FC      | ES | - | NIL | - |
| PET1012                      | Energy Sustainability Practices             | 3 | 0 | 0 | 3 | FC      | ES | - | NIL | - |
| <b>Physics Basket</b>        |                                             |   |   |   |   |         |    |   |     |   |
| PHY1003                      | Mechanics and Physics of Materials          | 3 | 0 | 0 | 3 | FC / SD |    |   |     |   |
| PHY1004                      | Astronomy                                   | 3 | 0 | 0 | 3 | FC      |    |   |     |   |
| PHY1005                      | Game Physics                                | 2 | 0 | 2 | 3 | FC / SD |    |   |     |   |
| PHY1006                      | Statistical Mechanics                       | 2 | 0 | 0 | 2 | FC      |    |   |     |   |
| PHY1007                      | Physics of Nanomaterials                    | 3 | 0 | 0 | 3 | FC      |    |   |     |   |
| PHY1008                      | Adventures in nanoworld                     | 2 | 0 | 0 | 2 | FC      |    |   |     |   |
| PHY2001                      | Medical Physics                             | 2 | 0 | 0 | 2 | FC      | ES |   |     |   |
| PHY2002                      | Sensor Physics                              | 1 | 0 | 2 | 2 | FC / SD |    |   |     |   |
| PHY2003                      | Computational Physics                       | 1 | 0 | 2 | 2 | FC      |    |   |     |   |
| PHY2004                      | Laser Physics                               | 3 | 0 | 0 | 3 | FC      | ES |   |     |   |
| PHY2005                      | Science and Technology of Energy            | 3 | 0 | 0 | 3 | FC      | ES |   |     |   |
| PHY2009                      | Essentials of Physics                       | 2 | 0 | 0 | 2 | FC      |    |   |     |   |
| <b>Management Basket- I</b>  |                                             |   |   |   |   |         |    |   |     |   |
| MGT2007                      | Digital Entrepreneurship                    | 3 | 0 | 0 | 3 | S/EM/EN | -  | - | -   | - |
| MGT2015                      | Engineering Economics                       | 3 | 0 | 0 | 3 | S       | -  | - | -   | - |
| MGT2023                      | People Management                           | 3 | 0 | 0 | 3 | S/EM/EN | HP | - | -   | - |
| <b>Management Basket- II</b> |                                             |   |   |   |   |         |    |   |     |   |

|                             |                                   |   |   |   |   |          |           |   |   |   |
|-----------------------------|-----------------------------------|---|---|---|---|----------|-----------|---|---|---|
| MGT1001                     | Introduction to Psychology        | 3 | 0 | 0 | 3 | F        | HP        | - | - | - |
| MGT1002                     | Business Intelligence             | 3 | 0 | 0 | 3 | EN       | -         | - | - | - |
| MGT1003                     | NGO Management                    | 3 | 0 | 0 | 3 | S        | -         | - | - | - |
| MGT1004                     | Essentials of Leadership          | 3 | 0 | 0 | 3 | EM/ EN   | GS/ HP    | - | - | - |
| MGT1005                     | Cross Cultural Communication      | 3 | 0 | 0 | 3 | S/EM/ EN | HP        | - | - | - |
| MGT2001                     | Business Analytics                | 3 | 0 | 0 | 3 | S/ EM/EN | -         | - | - | - |
| MGT2002                     | Organizational Behaviour          | 3 | 0 | 0 | 3 | F        | HP        | - | - | - |
| MGT2003                     | Competitive Intelligence          | 3 | 0 | 0 | 3 | S        | -         | - | - | - |
| MGT2004                     | Development of Enterprises        | 3 | 0 | 0 | 3 | S/EM/E N | -         | - | - | - |
| MGT2005                     | Economics and Cost Estimation     | 3 | 0 | 0 | 3 | S/EM     | -         | - | - | - |
| MGT2006                     | Decision Making Under Uncertainty | 3 | 0 | 0 | 3 | S        | -         | - | - | - |
| MGT2008                     | Econometrics for Managers         | 3 | 0 | 0 | 3 | S        | -         | - | - | - |
| MGT2009                     | Management Consulting             | 3 | 0 | 0 | 3 | S/EM/E N | -         | - | - | - |
| MGT2010                     | Managing People and Performance   | 3 | 0 | 0 | 3 | S/EM/E N | HP/GS     | - | - | - |
| MGT2011                     | Personal Finance                  | 3 | 0 | 0 | 3 | F        | -         | - | - | - |
| MGT2012                     | E Business for Management         | 3 | 0 | 0 | 3 | S/EM     | -         | - | - | - |
| MGT2013                     | Project Management                | 3 | 0 | 0 | 3 | EN / EM  | GS/HP/ ES | - | - | - |
| MGT2014                     | Project Finance                   | 3 | 0 | 0 | 3 | EN / EM  | HP        | - | - | - |
| MGT2016                     | Business of Entertainment         | 3 | 0 | 0 | 3 | EM/ EN   | -         | - | - | - |
| MGT2017                     | Principles of Management          | 3 | 0 | 0 | 3 | S/EM/ EN | -         | - | - | - |
| MGT2018                     | Professional and Business Ethics  | 3 | 0 | 0 | 3 | S/EM/ EN | HP        | - | - | - |
| MGT2019                     | Sales Techniques                  | 3 | 0 | 0 | 3 | S/EM/ EN | HP        | - | - | - |
| MGT2020                     | Marketing for Engineers           | 3 | 0 | 0 | 3 | S/EM/ EN | HP        | - | - | - |
| MGT2021                     | Finance for Engineers             | 3 | 0 | 0 | 3 | S/EM/ EN | HP        | - | - | - |
| MGT2022                     | Customer Relationship Management  | 3 | 0 | 0 | 3 | S/EM/ EN | HP        | - | - | - |
| <b>Media Studies Basket</b> |                                   |   |   |   |   |          |           |   |   |   |

|         |                                                    |   |   |   |   |    |    |   |   |   |
|---------|----------------------------------------------------|---|---|---|---|----|----|---|---|---|
| BAJ3050 | Corporate Filmmaking and Film Business             | 0 | 0 | 4 | 2 | EM | HP | - | - | - |
| BAJ3051 | Digital Photography                                | 2 | 0 | 2 | 3 | EM | HP | - | - | - |
| BAJ3055 | Introduction to News Anchoring and News Management | 0 | 0 | 2 | 1 | EM | -  | - | - | - |

## 21. List of MOOC Courses

21.1 Presidency University students are given the opportunity to study abroad in International Universities through a selection process coordinated by the Office of International Affairs (OIA). Such selected students need to complete their credits for the semester that they are abroad in the following way:

- 21.1.1. The student needs to study and complete School Core and Program Core Courses in offline mode only.
- 21.1.2. Massive Open Online Course (MOOC) courses maybe given for Open Elective and Discipline Elective Courses. These courses need to be approved by the concerned BOS and Academic Council from time to time.
- 21.1.3. SWAYAM/NPTEL/ other approved MOOCs shall be approved by the concerned Board of Studies and placed in the concerned PRC.
- 21.1.4. Student shall register for these courses in the ERP of Presidency University.
- 21.1.5. For these MOOC courses faculty coordinators are identified. These faculty should have undergone similar MOOC courses and therefore should be familiar with the mode of class conduction, types of assessments and evaluation procedures.
- 21.1.6. Study materials shall be provided to the students as video lectures shared by the MOOCs Coordinator(s), or the students may access the approved MOOCs Portal directly. The mode of class conduction is determined by the MOOCs coordinator(s) as detailed in the Course Catalogue and Course Plan.
- 21.1.7. The question paper shall be prepared by the MOOCs coordinator(s).
- 21.1.8. Students write the exams in online mode. These exams are scheduled and conducted by the School.
- 21.1.9. Results are evaluated by School and given to the Office of the Controller of Examinations (CoE).
- 21.1.10. The details of the duration, credits and evaluation are given below:

| Sl# | Duration | Credits | Evaluation                                                                  |
|-----|----------|---------|-----------------------------------------------------------------------------|
| 1.  | 12 weeks | 3       | Continuous Assessment –50 Marks<br>Mid Term –50 Marks<br>End Term-100 Marks |
| 2.  | 8 weeks  | 2       | Mid Term-50 Marks<br>End Term-100 Marks                                     |
| 3   | 4 weeks  | 1       | End Term-100 Marks                                                          |

## 21.2 List of MOOC – B.Tech. in Artificial Intelligence and Data Science

| Table 3.9: MOOC Discipline Elective Courses |             |                                                             |         |          |
|---------------------------------------------|-------------|-------------------------------------------------------------|---------|----------|
| Sl.No                                       | Course Code | Course Name                                                 | Credits | L-T-P-C  |
| 1                                           | CSE3111     | Artificial Intelligence: Search Methods for Problem Solving | 3       | 3-0-0-3  |
| 2                                           | CSE3112     | Privacy and Security in Online Social Media                 | 3       | 3-0-0-3  |
| 3                                           | CSE3113     | Computational Complexity                                    | 3       | 3-0-0-3  |
| 4                                           | CSE3114     | Deep Learning for Computer Vision                           | 3       | 3-0-0-3  |
| 5                                           | CSE3115     | Learning Analytics Tools                                    | 3       | 3-0-0-3  |
| 6                                           | CSE502      | Technical Skills in JAVA                                    | 3       | 0-0-6-3  |
| 7                                           | CSE503      | Technical Skills in Python                                  | 3       | 0-0-6-3  |
| 8                                           | CSE504      | Comprehensive Technical Skills                              | 5       | 0-0-10-5 |

|    |         |                                                                         |   |         |
|----|---------|-------------------------------------------------------------------------|---|---------|
| 9  | CSE505  | The Joy of Computing Using Python                                       | 3 | 3-0-0-3 |
| 10 | CSE3119 | Coding Skills in Python                                                 | 3 | 3-0-0-3 |
| 11 | CSE3121 | Parallel Computer Architecture                                          | 3 | 3-0-0-3 |
| 12 | CSE3124 | Games and Information                                                   | 3 | 3-0-0-3 |
| 13 | CSE3140 | Introduction to Industry 4.0 and Industrial Internet of Things          | 3 | 3-0-0-3 |
| 14 | CSE3142 | Affective Computing                                                     | 3 | 3-0-0-3 |
| 15 | CSE3196 | Foundations of Cyber Physical Systems                                   | 3 | 3-0-0-3 |
| 16 | CSE3197 | Getting Started with Competitive Programming                            | 3 | 3-0-0-3 |
| 17 | CSE3198 | GPU Architectures and Programming                                       | 3 | 3-0-0-3 |
| 18 | CSE3199 | Artificial Intelligence: Knowledge Representation and Reasoning         | 3 | 3-0-0-3 |
| 19 | CSE3200 | Programming in Modern C++                                               | 3 | 3-0-0-3 |
| 20 | CSE3201 | Circuit Complexity Theory                                               | 3 | 3-0-0-3 |
| 21 | CSE3202 | Basics of Computational Complexity                                      | 3 | 3-0-0-3 |
| 22 | CSE3212 | Introduction to Computer and Network Performance Analysis using Queuing | 1 | 1-0-0-1 |
| 23 | CSE3213 | C Programming and Assembly Language                                     | 1 | 1-0-0-1 |
| 24 | CSE3214 | Python for Data Science                                                 | 1 | 1-0-0-1 |
| 25 | CSE3215 | Software Conceptual Design                                              | 1 | 1-0-0-1 |
| 26 | CSE3117 | Industrial Digital Transformation                                       | 3 | 3-0-0-3 |
| 27 | CSE3118 | Blockchain for Decision Makers                                          | 3 | 3-0-0-3 |
| 28 | CSE3349 | Technology for Lawyers                                                  | 3 | 3-0-0-3 |
| 29 | CSE3430 | Deep Learning for Natural Language Processing                           | 3 | 3-0-0-3 |
| 30 | CSE3431 | Machine Learning for Engineering and Science Applications               | 3 | 3-0-0-3 |
| 31 | CSE3432 | Algorithms in Computational Biology and Sequence Analysis               | 3 | 3-0-0-3 |
| 32 | CSE3433 | Introduction to Large Language Models (LLMs)                            | 3 | 3-0-0-3 |
| 33 | CSE3434 | Quantum Algorithms and Cryptography                                     | 3 | 3-0-0-3 |
| 34 | CAI3430 | Responsible & Safe AI Systems                                           | 3 | 3-0-0-3 |
| 35 | CCS3416 | Practical Cyber Security for Cyber Security Practitioners               | 3 | 3-0-0-3 |
| 36 | IST3409 | Design & Implementation of Human-Computer Interfaces                    | 3 | 3-0-0-3 |

### 21.3 MOOC - Open Elective Courses for B. Tech. in Artificial Intelligence and Data Science

| Table 3.10: MOOC Open Elective Courses                                               |             |                           |               |         |
|--------------------------------------------------------------------------------------|-------------|---------------------------|---------------|---------|
| Courses duration is 4 weeks (01 credit)/ 8 weeks (02 credits)/ 12 weeks (03 credits) |             |                           |               |         |
| Sl. No.                                                                              | Course Code | Course Name               | Total Credits | L-T-P-C |
| 1                                                                                    | BBA2022     | Supply Chain digitization | 3             | 3-0-0-3 |
| 2                                                                                    | BBA2021     | E Business                | 3             | 3-0-0-3 |

|    |         |                                             |   |         |
|----|---------|---------------------------------------------|---|---------|
| 3  | BBB2016 | Business Analytics for Management Decisions | 3 | 3-0-0-3 |
| 4  | BBB2015 | Artificial Intelligence for Investments     | 3 | 3-0-0-3 |
| 5  | MEC3001 | Design and Development of Product           | 1 | 1-0-0-1 |
| 6  | ENG3004 | Perspectives of Neurolinguistics            | 1 | 1-0-0-1 |
| 7  | PPS4009 | Working in Contemporary Teams               | 1 | 1-0-0-1 |
| 8  | MGT3001 | Data Analysis and Decision Making           | 3 | 3-0-0-3 |
| 9  | MEC3001 | Design and Development of Product           | 1 | 1-0-0-1 |
| 10 | EEE3105 | Microsensors and Nanosensors                | 3 | 3-0-0-3 |
| 11 | CIV3065 | Drone Systems and Control                   | 3 | 3-0-0-3 |
| 12 | ECE3183 | Neural Networks for Signal Processing - I   | 3 | 3-0-0-3 |
| 13 | CIVXXXX | Disaster Management                         | 3 | 3-0-0-3 |

**22. Recommended Semester Wise Course Structure / Flow including the Programme / Discipline Elective Paths / Options**

| Sl. No.                       |           | Course Name                                                    | L         | T        | P         | Credits   | Contact Hours | Type of Skill | Pre-requisite | Basket |
|-------------------------------|-----------|----------------------------------------------------------------|-----------|----------|-----------|-----------|---------------|---------------|---------------|--------|
| <b>Semester 1 - PHY Cycle</b> |           |                                                                | <b>15</b> | <b>1</b> | <b>12</b> | <b>21</b> | <b>28</b>     |               |               |        |
| 1                             | MA T12 11 | Linear Algebra, Differential Equations and Statistical Methods | 3         | 1        | 0         | 4         | 4             | F             | Nil           | BSC    |
| 2                             | PHY 250 1 | Optoelectronics and Quantum Physics                            | 3         | 0        | 0         | 3         | 3             | F             | Nil           | BSC    |
| 3                             | MEC 100 6 | Engineering Graphics                                           | 2         | 0        | 0         | 2         | 2             | S             | Nil           | ESC    |
| 4                             | ENG 103 0 | Fundamentals of Communication                                  | 1         | 0        | 2         | 2         | 3             | S             | Nil           | HS MC  |
| 5                             | CSS 150 0 | Computational Thinking using Python                            | 2         | 0        | 2         | 3         | 4             | S             | Nil           | ESC    |
| 6                             | ECE 202 2 | Digital Design                                                 | 2         | 0        | 0         | 2         | 2             | F/S           | Nil           | ESC    |
| 7                             | ECE 151 2 | Design Thinking in Practice                                    | 2         | 0        | 2         | 3         | 4             | F             | Nil           | HS MC  |
| 8                             | PHY 250 4 | Optoelectronics and Quantum Physics Lab                        | 0         | 0        | 2         | 1         | 2             | F             | Nil           | BSC    |
| 9                             | PPS 102 5 | Industry Readiness Program - I                                 | 0         | 0        | 2         | 0         | 2             | SS            | Nil           | MA C   |
| 10                            | ECE 205 2 | Digital Design Lab                                             | 0         | 0        | 2         | 1         | 2             | F/S           | Nil           | ESC    |
| <b>Semester 2 - CHE Cycle</b> |           |                                                                | <b>14</b> | <b>1</b> | <b>12</b> | <b>20</b> | <b>27</b>     |               |               |        |

|                    |                 |                                                                       |    |   |   |    |    |          |             |          |
|--------------------|-----------------|-----------------------------------------------------------------------|----|---|---|----|----|----------|-------------|----------|
| 1                  | MA<br>T12<br>12 | Mathematical foundations for<br>Machine Learning and Data<br>Analysis | 3  | 1 | 0 | 4  | 4  | F        | Nil         | BSC      |
| 2                  | CIV<br>120<br>0 | Foundations of Integrated<br>Engineering                              | 2  | 0 | 0 | 2  | 2  | S        | Nil         | ESC      |
| 3                  | CHE<br>250<br>1 | Chemistry of Smart Materials                                          | 3  | 0 | 0 | 3  | 3  | S        | Nil         | BSC      |
| 4                  | CSS<br>220<br>0 | Problem Solving using C                                               | 2  | 0 | 0 | 2  | 2  | S        | Nil         | PCC      |
| 5                  | ENG<br>203<br>0 | Communication in Practice                                             | 1  | 0 | 2 | 2  | 3  | S        | Nil         | HS<br>MC |
| 6                  | EEE<br>120<br>0 | Basics of Electrical and Electronics<br>Engineering                   | 3  | 0 | 0 | 3  | 3  | F/S      | Nil         | ESC      |
| 7                  | CSS<br>220<br>1 | Problem Solving using C Lab                                           | 0  | 0 | 4 | 2  | 4  | S        | Nil         | PCC      |
| 8                  | CHE<br>250<br>2 | Chemistry of Smart Materials Lab                                      | 0  | 0 | 2 | 1  | 2  | S        | Nil         | BSC      |
| 9                  | PPS<br>102<br>6 | Industry Readiness Program – II                                       | 0  | 0 | 2 | 0  | 2  | S        | Nil         | MA<br>C  |
| 10                 | EEE<br>125<br>1 | Basics of Electrical and Electronics<br>Engineering Labtory           | 0  | 0 | 2 | 1  | 2  | F/S      | Nil         | ESC      |
| Sem<br>este<br>r 3 |                 |                                                                       | 19 | 2 | 8 | 23 | 29 |          |             |          |
| 1                  | CIV<br>760<br>1 | Universal Human Values and<br>Ethics                                  | 1  | 0 | 0 | 0  | 1  | S        | Nil         | MA<br>C  |
| 2                  | MA<br>T23<br>11 | Vector Calculus, Numerical<br>Methods and Sampling<br>Distributions   | 3  | 1 | 0 | 4  | 4  | EM       | Nil         | BSC      |
| 3                  | CSS<br>225<br>1 | Data Communication and<br>Computer Networks                           | 3  | 0 | 0 | 3  | 3  | S        | Nil         | PCC      |
| 4                  | CSS<br>227<br>8 | Data Structures and Analysis of<br>Algorithms                         | 3  | 1 | 0 | 4  | 4  | S/E<br>M | Nil         | PCC      |
| 5                  | CSS<br>228<br>8 | Data Structures and Analysis of<br>Algorithms Lab                     | 0  | 0 | 2 | 1  | 2  | S/E<br>M | Nil         | PCC      |
| 6                  | CSD<br>171<br>2 | Statistical Foundations of Data<br>Science                            | 3  | 0 | 0 | 3  | 3  | S        | MAT<br>2402 | PCC      |
| 7                  | CSD<br>171<br>3 | Statistical Foundations of Data<br>Science Lab                        | 0  | 0 | 2 | 1  | 2  | S        | MAT<br>2402 | PCC      |
| 8                  | CSS<br>225<br>5 | Object Oriented Programming<br>Using Java                             | 3  | 0 | 0 | 3  | 3  | S        | Nil         | PCC      |
| 9                  | CSS             | Object Oriented Programming                                           | 0  | 0 | 2 | 1  | 2  | S        | Nil         | PCC      |

|                    |                 |                                         |    |   |        |    |    |    |     |          |
|--------------------|-----------------|-----------------------------------------|----|---|--------|----|----|----|-----|----------|
|                    | 225<br>6        | Using Java Lab                          |    |   |        |    |    |    |     |          |
| 10                 | CSD<br>200<br>2 | Introduction to Data Science            | 3  | 0 | 0      | 3  | 3  | S  | NIL | PCC      |
| 11                 | APT<br>400<br>2 | Introduction to Aptitude                | 0  | 0 | 2      | 0  | 2  | AT | Nil | MA<br>C  |
| Sem<br>este<br>r 4 |                 |                                         | 20 | 0 | 1<br>0 | 23 | 30 |    |     |          |
| 1                  | CHE<br>760<br>1 | Environmental Studies                   | 1  | 0 | 0      | 0  | 1  | F  | Nil | MA<br>C  |
| 2                  | MA<br>T23<br>21 | Discrete Mathematical Structures        | 3  | 1 | 0      | 4  | 4  | F  | Nil | BSC      |
| 3                  | CSS<br>225<br>8 | Web Technologies                        | 3  | 0 | 0      | 3  | 3  | S  | Nil | PCC      |
| 4                  | CSS<br>225<br>9 | Web Technologies Lab                    | 0  | 0 | 2      | 1  | 2  | S  | Nil | PCC      |
| 5                  | CSS<br>226<br>0 | Database Management Systems             | 3  | 0 | 0      | 3  | 3  | S  | Nil | PCC      |
| 6                  | CSS<br>226<br>1 | Database Management Systems<br>Lab      | 0  | 0 | 2      | 1  | 2  | S  | Nil | PCC      |
| 7                  | ADS<br>210<br>7 | Exploratory Data Analysis               | 3  | 0 | 0      | 3  | 3  | S  | Nil | PCC      |
| 8                  | ADS<br>200<br>8 | Exploratory Data Analysis Lab           | 0  | 0 | 2      | 1  | 2  | S  | Nil | PCC      |
| 9                  | CSS<br>226<br>4 | Essentials of AI                        | 3  | 0 | 0      | 3  | 3  | S  | Nil | ESC      |
| 10                 | CSS<br>226<br>5 | Essentials of AI Lab                    | 0  | 0 | 2      | 1  | 2  | AT | Nil | ESC      |
| 11                 | FIN<br>100<br>2 | Essentials of Finance                   | 3  | 0 | 0      | 3  | 3  | S  | Nil | HS<br>MC |
| 12                 | APT<br>400<br>4 | Aptitude Training-Intermediate          | 0  | 0 | 2      | 0  | 2  | AT | Nil | MA<br>C  |
| Sem<br>este<br>r 5 |                 |                                         | 15 | 0 | 1<br>2 | 22 | 27 |    |     |          |
| 1                  | ADS<br>200<br>9 | Big Data Technologies                   | 3  | 0 | 0      | 3  | 3  | S  | Nil | PCC      |
|                    | CSD1<br>705     | Cloud Computing for Data Science        | 2  | 0 | 0      | 2  | 2  | S  | Nil | PCC      |
| 2                  | CSD<br>170      | Cloud Computing for Data Science<br>Lab | 0  | 0 | 2      | 1  | 2  | S  | Nil | PCC      |

|                   |                 |                                                                          |    |   |        |    |    |          |             |          |
|-------------------|-----------------|--------------------------------------------------------------------------|----|---|--------|----|----|----------|-------------|----------|
|                   | 6               |                                                                          |    |   |        |    |    |          |             |          |
| 3                 | CSD<br>202<br>1 | Machine Learning for Intelligent Data Science                            | 3  | 0 | 0      | 3  | 3  | S        | Nil         | PCC      |
| 4                 | CSD<br>202<br>4 | Machine Learning Lab for Intelligent Data Science Lab                    | 0  | 0 | 2      | 1  | 2  | S        | Nil         | PCC      |
| 5                 | CSS<br>226<br>9 | Operating Systems                                                        | 3  | 0 | 0      | 3  | 3  | S        | Nil         | PCC      |
| 7                 | CSD<br>200<br>9 | Data Handling and Visualization                                          | 2  | 0 | 0      | 2  | 2  | S        | Nil         | PCC      |
| 8                 | CSD<br>201<br>0 | Data Handling and Visualization Lab                                      | 0  | 0 | 4      | 2  | 4  | S        | Nil         | PCC      |
| 9                 | CSS<br>XXX<br>X | Professional Elective - I                                                | 2  | 0 | 2      | 3  | 4  | S/E<br>M | Nil         | PEC      |
| 10                | CSS<br>700<br>0 | Internship                                                               | 0  | 0 | 0      | 2  | 0  | S/E<br>M | Nil         | PR<br>W  |
| 11                | APT<br>400<br>6 | Logical and Critical Thinking                                            | 0  | 0 | 2      | 0  | 2  | AT       | Nil         | HS<br>MC |
| Sem<br>ester<br>6 |                 |                                                                          | 17 | 0 | 1<br>6 | 24 | 33 |          |             |          |
| 1                 | LA<br>W7<br>601 | Indian Constitution                                                      | 1  | 0 | 0      | 0  | 1  | F        | Nil         | MA<br>C  |
| 2                 | CSS<br>227<br>1 | Software Design and Development                                          | 3  | 0 | 0      | 3  | 3  | S        | Nil         | PCC      |
| 3                 | ADS<br>250<br>5 | Deep Learning and Reinforcement Learning Techniques for Data Science     | 3  | 0 | 0      | 3  | 3  | S        | CSE2<br>064 | PCC      |
| 4                 | ADS<br>250<br>6 | Deep Learning and Reinforcement Learning Techniques for Data Science Lab | 0  | 0 | 4      | 2  | 4  | S        | CSE2<br>064 | PCC      |
| 5                 | ADS<br>250<br>3 | Natural Language Understanding and Analytics                             | 3  | 0 | 0      | 3  | 3  | S        | CSE1<br>500 | PCC      |
| 6                 | ADS<br>250<br>4 | Natural Language Understanding and Analytics Lab                         | 0  | 0 | 2      | 1  | 2  | S        | CSE1<br>500 | PCC      |
| 7                 | CSS<br>227<br>4 | Competitive Programming and Problem Solving                              | 0  | 0 | 4      | 2  | 4  | S/E<br>M | Nil         | ESC      |
| 8                 | CSS<br>XXX<br>X | Professional Elective - II                                               | 2  | 0 | 2      | 3  | 4  | S/E<br>M | Nil         | PEC      |
| 9                 | CSS<br>XXX<br>X | Professional Elective - III                                              | 2  | 0 | 2      | 3  | 4  | S/E<br>M | Nil         | PEC      |
| 10                | XXX<br>XXX<br>X | Open Elective - I                                                        | 3  | 0 | 0      | 3  | 3  | S        | Nil         | OEC      |

|                |                 |                            |         |   |        |     |     |          |     |          |
|----------------|-----------------|----------------------------|---------|---|--------|-----|-----|----------|-----|----------|
| 11             | APT<br>400<br>5 | Aptitude for Employability | 0       | 0 | 2      | 1   | 2   | AT       | Nil | HS<br>MC |
| Sem<br>ester 7 |                 |                            | 9       | 0 | 8      | 17  | 17  |          |     |          |
| 1              | CSS<br>XXX<br>X | Professional Elective – IV | 2       | 0 | 2      | 3   | 4   | S/E<br>M | Nil | PEC      |
| 2              | CSS<br>XXX<br>X | Professional Elective – V  | 2       | 0 | 2      | 3   | 4   | S/E<br>M | Nil | PEC      |
| 3              | CSS<br>XXX<br>X | Professional Elective – VI | 2       | 0 | 2      | 3   | 4   | S/E<br>M | Nil | PEC      |
| 4              | XXX<br>XXX<br>X | Open Elective – II         | 3       | 0 | 0      | 3   | 3   | S        | Nil | OEC      |
| 5              | CSS<br>710<br>0 | Mini Project               | 0       | 0 | 0      | 4   | 0   | S/E<br>M | Nil | PR<br>W  |
| 6              | PPS<br>301<br>8 | Preparedness for Interview | 0       | 0 | 2      | 1   | 2   | SS       | Nil | HS<br>MC |
| Sem<br>ester 8 |                 |                            | 0       | 0 | 0      | 10  | 0   |          |     |          |
| 1              | CSS<br>730<br>0 | Capstone Project           | 0       | 0 | 0      | 10  | 0   | S/E<br>M | Nil | PR<br>W  |
|                |                 |                            | 10<br>9 | 4 | 7<br>8 | 160 | 191 |          |     |          |

## Course Catalogue

|                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |                             |   |   |   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-----------------------------|---|---|---|
| <b>Course Code:</b><br>MAT1211                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Course Title:</b> Linear Algebra, Differential Equations and Statistical Methods<br><b>Type of Course:</b> 1] School Core                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | - P- C | 3                           | 1 | 0 | 4 |
| <b>Version No.</b>                                                                                                                                                                                                                                                                                                                                                                                                             | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |                             |   |   |   |
| <b>Course Pre-requisites</b>                                                                                                                                                                                                                                                                                                                                                                                                   | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |                             |   |   |   |
| <b>Anti-requisites</b>                                                                                                                                                                                                                                                                                                                                                                                                         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |                             |   |   |   |
| <b>Course Description</b>                                                                                                                                                                                                                                                                                                                                                                                                      | This course introduces fundamental mathematical concepts from linear algebra, differential calculus, ordinary differential equations and statistics. The content includes matrices, systems of linear equations, eigenvalues and eigenvectors, functions of several variables, differential equations, correlation and regression analysis, and curve fitting techniques. The course combines theoretical developments with illustrative applications drawn from scientific and engineering settings. The course emphasizes the application of these mathematical tools in solving problems in science and engineering. It extends student's problem-solving abilities through analytical and computational approaches, with focus on both theoretical understanding and applications. |        |                             |   |   |   |
| <b>Course Objective</b>                                                                                                                                                                                                                                                                                                                                                                                                        | The objective of this course is to provide students with a strong mathematical foundation required for engineering and scientific studies. The course introduces fundamental concepts from linear algebra, differential calculus, ordinary differential equations, and statistical methods that are widely used in modeling, analysis and problem solving. It aims to familiarize students with mathematical techniques for representing engineering systems, studying relationships among variables, describing dynamic processes and interpreting data. The course serves as a foundation to prepare students for advanced engineering subjects that rely on mathematical modeling, computation and analytical methods.                                                              |        |                             |   |   |   |
| <b>Course Out Comes</b>                                                                                                                                                                                                                                                                                                                                                                                                        | On successful completion of the course the students shall be able to:<br><b>CO1:</b> Use linear algebra concepts to evaluate properties of matrices and quadratic forms. (L3)<br><b>CO2:</b> Apply matrix-based methods to solve systems of linear equations. (L3)<br><b>CO3:</b> Use fundamental theorems and analytical techniques of differential calculus to single variable functions. (L3)<br><b>CO4:</b> Apply the concepts of partial derivatives to multivariable functions. (L3)<br><b>CO5:</b> Solve first order ordinary differential equations using analytical methods. (L3)<br><b>CO6:</b> Employ statistical techniques for data analysis and to interpret relationships between variables. (L3)                                                                       |        |                             |   |   |   |
| <b>Course Content:</b>                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |                             |   |   |   |
| <b>Module 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Fundamentals of Linear Algebra</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        | <b>(15L+5T=20 Sessions)</b> |   |   |   |
| Matrices, echelon forms, rank of matrix, Systems of linear equations: Consistency, solution to system of linear homogeneous and non-homogeneous equations- Gauss elimination method, Gauss-Jordan method (Self-study), LU decomposition method, Network analysis using linear systems, Design of traffic patterns, Electrical circuits.<br>Eigenvalue and eigenvector, diagonalization of symmetric matrices, quadratic forms. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |                             |   |   |   |
| <b>Module 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Differential Calculus</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        | <b>(15L+5T=20 Sessions)</b> |   |   |   |
| Introduction, limit, continuity, Rolle's theorem, mean value theorems, Indeterminate forms and L'Hôpital's rule.<br>Partial derivatives, Euler's theorem, total derivative, Jacobians, Taylor's and Maclaurin's theorems, maxima, minima and saddle points, method of Lagrange multipliers, Current Growth in an RL Circuit, Velocity Estimation, Fuel consumption optimization, Cost function optimization.                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |                             |   |   |   |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Ordinary Differential Equations</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        | <b>(6L+2T=8 Sessions)</b>   |   |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                              |                            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|----------------------------|
| Definition, types of differential equations-variable separable, homogeneous, exact, linear and Bernoulli's equations, Equations not of first degree: equations solvable for $p$ , equations solvable for $y$ , equations solvable for $x$ and Clairaut's type, Newton's law of cooling, Current in RL circuit.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |                            |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>Statistical Methods and Curve Fitting</b> | <b>(9L+3T=12 Sessions)</b> |
| Measures of central tendency, moments, skewness, and kurtosis. Correlation - Karl Pearson's coefficient of correlation, rank correlation, multiple correlation. Regression analysis - lines of regression, multiple regression. Principle of least square, curve fitting- straight line, parabola and exponential curves, Stress and strain curve fitting, Feature selection and Prediction models.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                              |                            |
| <p>Targeted Applications &amp; Tools that can be used:</p> <ul style="list-style-type: none"> <li>• Linear Algebra is applied to solve systems of equations in circuits, traffic flow, and network analysis, with eigenvalues and quadratic forms aiding stability and optimization studies.</li> <li>• Differential Calculus supports process speed analysis, velocity estimation, and optimization techniques such as minimizing fuel consumption and cost functions.</li> <li>• Differential Equations model dynamic behaviours like current in RL circuits, heat transfer in materials, and growth or decay in environmental and nuclear engineering.</li> <li>• Statistical Methods and Curve Fitting enable effective data analysis through correlation, regression, and curve fitting, supporting predictive modeling and interpretation of experimental data such as stress-strain relationships.</li> </ul> <p>Software: MATLAB, Python, R Programming, Mathematica, Scilab, Octave</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                              |                            |
| <b>Assignment:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                              |                            |
| Select any one simple differential equation pertaining to the respective branch of engineering, identify the dependent and independent variable – obtain the solution and compare the solution sets by varying the values of the dependent variable.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                              |                            |
| <p><b>Text Book</b></p> <ol style="list-style-type: none"> <li>1. B. S. Grewal, <i>Higher Engineering Mathematics</i>, 44th ed. New Delhi, India: Khanna Publishers, 2017.</li> <li>2. D. C. Montgomery and G. C. Runger, <i>Applied Statistics and Probability for Engineers</i>, 7th ed. Hoboken, NJ, USA: Wiley, 2018.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                              |                            |
| <p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. P. V. O'Neil, <i>Advanced Engineering Mathematics</i>, 8th ed. Boston, MA, USA: Cengage Learning, 2018.</li> <li>2. R. I. Miller and J. E. Freund, <i>Probability and Statistics for Engineers</i>, 9th ed. Noida, India: Pearson Education Ltd., 2017.</li> <li>3. E. Kreyszig, <i>Advanced Engineering Mathematics</i>, 10th ed. Hoboken, NJ, USA: John Wiley &amp; Sons, 2011.</li> <li>4. V. Henner, T. Belozero, and M. Khenner, <i>Ordinary and Partial Differential Equations</i>. Boca Raton, FL, USA: CRC Press, 2013.</li> </ol> <p><b>E-resources/ Web links:</b></p> <ol style="list-style-type: none"> <li>1. <a href="https://nptel.ac.in/courses/111105121">https://nptel.ac.in/courses/111105121</a></li> <li>2. <a href="https://nptel.ac.in/courses/111106146">https://nptel.ac.in/courses/111106146</a></li> <li>3. <a href="https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&amp;unique_id=EBSCO95_30102024_106839">https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&amp;unique_id=EBSCO95_30102024_106839</a></li> <li>4. <a href="https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&amp;unique_id=EBSCO95_30102024_61605">https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&amp;unique_id=EBSCO95_30102024_61605</a></li> <li>5. <a href="https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&amp;unique_id=EBSCO95_30102024_134719">https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&amp;unique_id=EBSCO95_30102024_134719</a></li> <li>6. <a href="https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&amp;unique_id=TEXTBOOK_LIBRARY01_06082022_174">https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&amp;unique_id=TEXTBOOK_LIBRARY01_06082022_174</a></li> </ol> |                                              |                            |
| <b>Topics relevant to SKILL DEVELOPMENT:</b> The course focuses on the concepts of differential calculus, differential equations and statistical methods with reference to specific engineering problems. The course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                              |                            |

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| is of both conceptual and analytical type in nature through Problem solving. This is attained through the assessment component mentioned in course handout. |                                                                      |
|                                                                                                                                                             |                                                                      |
| <b>Catalogue prepared by</b>                                                                                                                                | <b>Dr. Kavita Permi, Dr. Rahul M. P. and Dr. Athmakoori Prashant</b> |
| <b>Recommended by the Board of Studies on</b>                                                                                                               |                                                                      |
| <b>Date of Approval by the Academic Council</b>                                                                                                             |                                                                      |

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| Course Code: PHY2501                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Course Title: Optoelectronics and Quantum Physics<br>Type of Course: School Core                                                                                                                                                                                                                                                                                                                                                                                                                                              | L-T-P-C    | 3-0-0-3     |
| Version No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |             |
| Course Pre-requisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |             |
| Anti-requisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |             |
| Course Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | The purpose of this course is to enable the students to understand the fundamentals, working and applications of optoelectronic devices and to develop the basic abilities to appreciate the applications of advanced microscopy and quantum computers. The course develops the critical thinking and analytical skills.                                                                                                                                                                                                      |            |             |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | On successful completion of the course the students shall be able to:<br><b>CO1:</b> Understand the concepts of electrical conductingLevel 2 – Understand properties of metal, semiconductor, and superconductivity.<br><b>CO2:</b> Understand the principles of quantum mechanics. Level 2 – Understand<br><b>CO3:</b> Discuss the quantum concepts used in quantumLevel 2 – Understand computers.<br><b>CO4:</b> Explain the applications of lasers and optical fibers inLevel 2 – Understand various technological fields. |            |             |
| Course Objective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | The objective of the course is to familiarize the learners with the concepts of “Applied Physics for Computer Science Cluster “and to attain the basic knowledge related to quantum mechanics and computation.                                                                                                                                                                                                                                                                                                                |            |             |
| Course Content:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |            |             |
| Module 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Electrical Conductivity Of Solids And Semiconducting Devices                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Assignment | 11 Sessions |
| Topics: Classification of materials based on bandgap, Fermi energy and Fermi level, Fermi level in semiconductors, Law of mass action, Electrical conductivity of a semiconductor, Hall effect, Superconductivity, p-n junctions, Zener diode, Solar cells, I-V characteristics, and LEDs                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |            |             |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Quantum Mechanics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Assignment | 11 Sessions |
| Topics: Introduction, de-Broglie hypothesis, Heisenberg’s uncertainty principle- statement and physical significance. Wave function-properties and physical significance. Schrodindger’s time independent wave equation, Probability density and normalization of wave function. Wave Function in Ket Notation: Matrix form of wave function, Identity operator, Determination of $I 0\rangle$ and $I 1\rangle$ , Pauli Matrices and its operations on 0 and 1 states, Mention of Conjugate and Transpose, Unitary Matrix U, Examples: 2x2 Matrices and their multiplication (Inner Product), Probability, Orthogonality |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |            |             |
| Module 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Quantum Computing                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Term paper | 12 Sessions |
| Topics: Introduction to quantum computing, Moore’s law & its end, Differences between classical and quantum computing, Concept of Qubit and its properties, . Representation of qubit by Bloch sphere, Quantum Gates: Single Qubit Gates: Quantum Not Gate, Pauli Z Gate, Hadamard Gate, Phase Gate (or S                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |            |             |

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| Gate), T Gate. Multiple Qubit Gates: Controlled gate - CNOT Gate, (Discussion for 4 different input states). Representation of Swap gate, Controlled - Z gate, Toffoli gate. Problems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                  |     |         |                           |
| Module 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Lasers<br>Fibers | And | Optical | Term paper<br>11 Sessions |
| Topics: Interactions of radiations with matter, expression for energy density of a system under thermal equilibrium in terms of Einstein's coefficients, conditions for LASER action using Einstein's coefficients, Characteristics of laser, conditions and requisites of laser, Principle of optical fibers, Numerical aperture and acceptance angle (Qualitative), Attenuation, Applications: Point to point communication with block diagram, application of optical fibers in endoscopy.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                  |     |         |                           |
| Targeted Application & Tools that can be used:<br>Areas of application are optoelectronics industry, Solar panel technologies, quantum computing software, electronic devices using transistors and diodes, memory devices, endoscopy, SQUIDS in MRI, Advanced material characterizations using SEM and STM.<br>Origin, excel and Mat lab soft wares for programming and data analysis.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                  |     |         |                           |
| Project work/Assignment: Mention the Type of Project /Assignment proposed for this course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                  |     |         |                           |
| Assessment Type<br>Midterm exam<br>Assignment (review of digital/ e-resource from PU link given in references section - mandatory to submit screen shot accessing digital resource.)<br>Quiz<br>End Term Exam<br>Self-Learning<br>1. Prepare a comprehensive report on non-conventional energy resources in Karnataka and their pros and cons.<br>2. Write a report on importance of quantum entanglement in supercomputers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                  |     |         |                           |
| Text Book<br>Engineering Physics by Avadhanalu, Revised edition, S. Chand Publications, 2024.<br>Quantum Computation and Quantum Information, Michael A. Nielsen & Isaac L. Chuang, Cambridge Universities Press, 2010 Edition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                  |     |         |                           |
| References: 1. Elementary Solid state Physics: Principles and Applications by M.A. Omar, 1st Edition, Pearson Publications, 2002.<br>2. Principles of Quantum Mechanics by R Shankar, 2nd edition, springer Publications, 2011.<br>3. Optoelectronics: An Introduction by John Wilson and John Hawkes, 3rd edition, Pearson Publications, 2017.<br>4. Engineering Physics by Gaur and Gupta, Dhanpat Rai Publications, 2012.<br>5. Introduction to Quantum Mechanics, David J <a href="#">Griffiths</a> , Cambridge University Press, 2019                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                  |     |         |                           |
| E-Resources:<br><a href="https://search.ebscohost.com/login.aspx?direct=true&amp;db=nlebk&amp;AN=553045&amp;site=ehost-live">https://search.ebscohost.com/login.aspx?direct=true&amp;db=nlebk&amp;AN=553045&amp;site=ehost-live</a><br><a href="https://search.ebscohost.com/login.aspx?direct=true&amp;db=nlebk&amp;AN=833068&amp;site=ehost-live">https://search.ebscohost.com/login.aspx?direct=true&amp;db=nlebk&amp;AN=833068&amp;site=ehost-live</a><br><a href="https://search.ebscohost.com/login.aspx?direct=true&amp;db=nlebk&amp;AN=323988&amp;site=ehost-live">https://search.ebscohost.com/login.aspx?direct=true&amp;db=nlebk&amp;AN=323988&amp;site=ehost-live</a><br><a href="https://search.ebscohost.com/login.aspx?direct=true&amp;db=nlebk&amp;AN=1530910&amp;site=ehost-live">https://search.ebscohost.com/login.aspx?direct=true&amp;db=nlebk&amp;AN=1530910&amp;site=ehost-live</a><br><a href="https://search.ebscohost.com/login.aspx?direct=true&amp;db=nlebk&amp;AN=486032&amp;site=ehost-live">https://search.ebscohost.com/login.aspx?direct=true&amp;db=nlebk&amp;AN=486032&amp;site=ehost-live</a> |                  |     |         |                           |
| Topics relevant to "SKILL DEVELOPMENT": Fundamentals of materials, Lasers and optical fibers. for Skill Development through Participative Learning Techniques. This is attained through the Assignment/ Presentation as mentioned in the assessment component in course handout.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                  |     |         |                           |

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| Course Code: MEC1006  | Course Title: Engineering Graphics<br>Type of Course: School Core & Theory Only | L- T- P- C | 2-0-0-2 |
| Version No.           | 1.2                                                                             |            |         |
| Course Pre-Requisites | NIL                                                                             |            |         |

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| Anti-requisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |            |                             |            |
| Course Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | The course is designed with the objective of giving an overview of engineering graphics. It is introductory in nature and acquaints the students with the techniques used to create engineering drawings. The course emphasizes on projection of points, lines, planes and solids and isometric projections.                                                                                                                                                                                                                                                                                                                          |            |                             |            |
| Course Objective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | The objective of the course is to familiarize the learners with the concepts of “Engineering Graphics” and attain SKILL DEVELOPMENT through Problem solving methodologies.                                                                                                                                                                                                                                                                                                                                                                                                                                                            |            |                             |            |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | On successful completion of this course the students shall be able to:<br><b>CO1:</b> Demonstrate competency in Engineering Graphics as per BIS Level 3 – Apply conventions and standards.<br><b>CO2:</b> Comprehend the theory of projection for drawing projections Level 2 – Understand of points, lines, and planes under different conditions.<br><b>CO3:</b> Prepare multiview orthographic projections of solids by Level 3 – Apply visualizing them in different positions.<br><b>CO4:</b> Prepare pictorial drawings using the principles of isometric Level 3 – Apply projections to visualize objects in three dimensions. |            |                             |            |
| Course Content:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |            |                             |            |
| Module 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Introduction to Drawing                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Assignment | Standard technical drawing  | 7 Sessions |
| Topics:<br>Introduction, drawing instruments and their uses, relevant BIS conventions and standards, Lettering, Line conventions, dimensioning, Selection of drawing sheet size and scale.<br>[02 Hours: Comprehension Level]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |            |                             |            |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Orthographic projections of Points, Straight Lines and Plane Surfaces                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Assignment | Projection methods Analysis | 7 Sessions |
| Topics:<br>Introduction, Definitions – Elements of projection and methods of projection, Planes of projection, reference line and conventions adopted. First angle and third angle projections. Projection of Points in all 4 quadrants. Projections of Straight Lines (located in first quadrant/first angle projection only): True and apparent lengths, true and apparent Inclinations to reference planes. (No application problems). Projection of Plane surfaces (First angle projection): Regular plane surfaces – triangle, square, rectangle, pentagon, hexagon and circle – in different positions inclined to both the planes using change of position method only.<br>[10 Hours: Application Level] |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |            |                             |            |
| Module 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Orthographic Projections of Solids                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Assignment | Multi-view drawing Analysis | 8 Sessions |
| Topics:<br>Introduction, Projection of right regular prisms, pyramids, cone, hexahedron and tetrahedron in different positions (Problems resting on HP only and First angle projection).<br>[10 Hours: Application Level]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |            |                             |            |

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| Module 4                                                                                                                                                                                                                                                                                                                                                                                                       | Isometric Projections of Solids (Using isometric scale only) | Assignment | Spatial Visualization | 8 Sessions |
| <p>Topics:<br/>Introduction, Isometric scale, Isometric projections of right regular prisms, cylinders, pyramids, cones and their frustums, spheres and hemispheres, hexahedron (cube), and combination of 2 solids, conversion of orthographic view to isometric projection of simple objects.<br/>[8 Hours: Application Level]</p>                                                                           |                                                              |            |                       |            |
| <p>Text Book:<br/>1.N. D. Bhatt, "Engineering Drawing: Plane and Solid Geometry," Charotar Publishing House Pvt. Ltd.</p>                                                                                                                                                                                                                                                                                      |                                                              |            |                       |            |
| <p>References:<br/>K.R. Gopalakrishna, "Engineering Graphics", Subhash Publishers, Bangalore.<br/>D. M. Kulkarni, A. P. Rastogi, A. K. Sarkar, "Engineering Graphics with AutoCAD," Prentice Hall.<br/>D. A. Jolhe, "Engineering Drawing with Introduction to AutoCAD," Tata McGraw Hill.<br/>Web resources:<br/><a href="https://nptel.ac.in/courses/112103019">https://nptel.ac.in/courses/112103019</a></p> |                                                              |            |                       |            |
| <p>Topics relevant to "SKILL DEVELOPMENT": Projection in first and third angle for SKILL DEVELOPMENT through Problem Solving methodologies. This is attained through the assessment component mentioned in the course handout.</p>                                                                                                                                                                             |                                                              |            |                       |            |

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| <b>Course Code:</b><br>ENG1030                       | <b>Course Title:</b> Fundamentals of Communication<br><b>Type of Course:</b> Integrated                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>L-T-P-C</b> | 1 | 0 | 2 | 2 |
| <b>Version No.</b>                                   | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                |   |   |   |   |
| <b>Course Pre-requisites</b>                         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                |   |   |   |   |
| <b>Anti-requisites</b>                               | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                |   |   |   |   |
| <b>Course Description</b>                            | Fundamentals of Communication is a lab intensive, practice first integrated course designed to introduce first-year undergraduate engineering and computer science students to the foundational principles and advanced applications of effective communication across interpersonal, spoken, written, and digital contexts. Anchored in real world scenarios directly relevant to college life, cross-functional technical teams, and digital workplaces, the curriculum develops students' abilities to navigate cultural differences, speak with clarity, read texts critically, and write with precise audience awareness. The course explicitly relies on scenario-based learning, interactive case studies, and hands-on lab applications to ensure that theoretical communication frameworks are immediately actionable. By guiding students from reflective self-awareness to complex digital and AI-mediated content creation, the course builds an enduring communicative foundation optimized for performance-oriented professional practice.                                                                                                                                                           |                |   |   |   |   |
| <b>Course Objective</b>                              | The course aims to explain the key principles of interpersonal, intercultural, and professional communication and apply them to real-world scenarios. It also focuses on developing spoken communication strategies, including structured delivery and impromptu responses, for academic and group contexts. Furthermore, it aims to develop effective writing skills to produce clear, coherent, and audience-appropriate texts across formal and professional contexts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                |   |   |   |   |
| <b>Course Outcomes</b>                               | <b>On successful completion of this course the students shall be able to:</b><br><div><div>1. <b>Understand</b> the principles of interpersonal, intercultural, and professional communication in academic, social, and technical team contexts.</div><div>2. <b>Demonstrate</b> audience-centered spoken communication in individual presentations, group discussions, and simulated professional scenarios through vocal control, adaptive register, and collaborative engagement.</div><div>3. <b>Interpret</b> written, multimodal, and AI-generated texts to identify underlying assumptions, rhetorical strategies, logical errors, and credibility markers across diverse media and professional contexts.</div><div>4. <b>Utilize</b> plain-language principles and professional conventions to produce clear, purposeful, and appropriately formatted written and multimodal communication, including technical content adapted for non-specialist audiences.</div><div>5. <b>Employ</b> responsible and critical practices in AI-assisted communication by designing iterative prompts, evaluating generated outputs, and applying ethical frameworks in academic and professional contexts.</div></div> |                |   |   |   |   |
| <b>Course Content:</b> Fundamentals of Communication |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                |   |   |   |   |

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| <b>Module 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Communication in a New World</b>    | <b>CA1 + Project Milestone</b>  | <b>Deep Listening and Contextual Response Lab</b>                                                                                            | <b>06 Sessions</b> |
| <p>The topics will be discussed through case studies:</p> <ul style="list-style-type: none"> <li>• The Communication Process: How Messages Are Sent, Received, and Misread</li> <li>• Verbal, Non-Verbal, and Vocal Communication in Everyday Contexts</li> <li>• Communication Breakdown: Recognising Barriers Across Psychological, Cultural, and Semantic Dimensions</li> <li>• Active Listening: Attention, Paraphrasing, and Purposeful Response; asking for clarification</li> <li>• Interpersonal Communication and Self-Awareness (<i>including cross-cultural dimensions</i>)</li> </ul>                                                                                                                                                           |                                        |                                 |                                                                                                                                              |                    |
| <b>Module 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Contemporary Speaking Practices</b> | <b>CA2, CA3, CA4</b>            | <b>Narrative and Adaptive Oral Delivery</b><br><b>Facilitated Stakeholder Group Discussion</b><br><b>Simulated Workplace Crisis Briefing</b> | <b>15 Sessions</b> |
| <p>The topics will be discussed through structured, individual presentations and group discussions:</p> <ul style="list-style-type: none"> <li>• Elements of Spoken Communication: Voice, Clarity, and Presence</li> <li>• Storytelling and Narrative in Spoken Contexts</li> <li>• Structuring Spoken Messages: From Idea to Delivery</li> <li>• Speaking with Confidence: Managing Anxiety and Building Presence</li> <li>• Communicating in Groups: Participation, Productive Disagreement, and Turn-Taking</li> <li>• Giving and Receiving Feedback Effectively</li> <li>• Presentation Design and Delivery: Structure, Evidence, and Audience Engagement; eliciting responses</li> <li>• Speaking for Technical and Non-Technical Audiences</li> </ul> |                                        |                                 |                                                                                                                                              |                    |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Critical Reading</b>                | <b>Project Milestone</b>        | <b>Source Audit and Fallacy Brief</b>                                                                                                        | <b>09 Sessions</b> |
| <p>The topics will be discussed through case studies and real-world scenarios:</p> <ul style="list-style-type: none"> <li>• Critical Reading: Purpose, Context, and Analytical Approach</li> <li>• Perspective and Persuasion: Identifying Tone, Bias, and the Fact-Opinion Distinction</li> <li>• Understanding Flawed Reasoning (<i>patterns of weak argumentation in everyday contexts</i>)</li> <li>• Evaluating Sources: Credibility, Reliability, and AI-Generated Content; accuracy of the content</li> <li>• Reading Multimodal Texts: Images, Infographics, and Digital Media</li> </ul>                                                                                                                                                           |                                        |                                 |                                                                                                                                              |                    |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Writing with Purpose</b>            | <b>CA 5 + Project Milestone</b> | <b>Technical Translation and Annotated Script</b>                                                                                            | <b>09 Sessions</b> |
| <p>The topics will be discussed through case studies:</p> <ul style="list-style-type: none"> <li>• Principles of Effective Writing: Clarity, Coherence, Precision and Concise; audience analysis</li> <li>• Plain Language and Technical Communication: Making Complex Ideas Accessible</li> <li>• Writing for Professional Contexts: Email, Formal Reports, and Correspondence</li> <li>• Argumentative Writing: Claim, Evidence, and Logical Progression</li> </ul>                                                                                                                                                                                                                                                                                       |                                        |                                 |                                                                                                                                              |                    |

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| <ul style="list-style-type: none"> <li>Summary Writing and Short-Form Academic Response</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                       |                                 |                                                           |                    |
| <b>Module 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Communication in the Age of AI</b> | <b>CA 6 – Project Milestone</b> | <b>CA 6: Cross-Disciplinary Case Analysis and Defence</b> | <b>06 Sessions</b> |
| <p>The topics will be discussed through case studies featuring real-world examples:</p> <ul style="list-style-type: none"> <li>AI as a Communication Tool: Capabilities, Limitations, and the Hallucination Problem</li> <li>Prompt Engineering: Communicating Effectively with AI Systems</li> <li>AI-Assisted Writing: Drafting, Refining, and Maintaining Your Voice</li> <li>Ethical and Legal Dimensions of AI in Communication (<i>includes India's Digital Personal Data Protection Act, 2023</i>)</li> <li>AI, Bias, and Critical Evaluation: Reading AI Outputs Responsibly</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                       |                                 |                                                           |                    |
| <p><b>Targeted Application &amp; Tools that can be used:</b> Otter.ai, Microsoft Word/PowerPoint/Teams/Clipchamp/Whiteboard/OneNote/Forms/Copilot, Miro, Padlet, Canva, Mentimeter, AllSides Media Bias Ratings, Ad Fontes Media Bias Chart, Snopes/factcheck.rog, Zotero, NotebookLM, Canva, Adobe Express, CapCut, OBS Studio, Claude, ChatGPT, Gemini, DeepSeek, Google Docs</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                       |                                 |                                                           |                    |
| <p><b>Project Work / Assignment:</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                       |                                 |                                                           |                    |
| <ol style="list-style-type: none"> <li><b>Multimodal Communication Portfolio</b> (Project) with multiple milestones: Continuous, milestone based. Developed across all five modules. Final consolidated submission at the end of the course. Develop a progressive, publicly shareable communication portfolio that demonstrates the student's ability to move a technical concept across multiple audiences, formats, and media.</li> <li><b>Active Listening and Contextual Response Lab</b> (Individual): Students listen to an unedited, multi-speaker audio recording of a real or simulated professional scenario. Under timed conditions, students produce a structured written brief consisting of four parts. Assessed on comprehension accuracy, analytical precision, quality of questioning, and practicality of the proposed strategy.</li> <li><b>Narrative and Adaptive Oral Delivery</b> (Individual): Each student delivers a 4-minute structured presentation. At the 3-minute mark, the faculty assessor introduces a counter-perspective or an unexpected constraint, and the student must adapt their argument in real time for the remaining minute. The assessment evaluates: the quality of the prepared 3 minutes; the quality of the improvised adaptation; and the degree to which the full 4 minutes function as a coherent whole.</li> <li><b>Facilitated Stakeholder Group Discussion</b> (Group): Groups of 5–6 students are each assigned a distinct stakeholder position within a shared scenario. and must engage in a live, facilitated discussion to resolve a stated policy impasse. No prepared scripts are permitted; students receive their role brief 15 minutes before the discussion begins. Assessment is individual, not group-level.</li> <li><b>Simulated Workplace Crisis Briefing</b> (Group): Groups of 4–5 students receive an unexpected corporate or institutional emergency brief. Teams have exactly 30 minutes to read the brief, distil the critical information, assign speaking roles, and prepare a 5-minute status update for a simulated leadership panel.</li> <li><b>Technical Translation and Annotated Script</b> (Individual): Students receive a dense, jargon-heavy technical document. Students must: (a) read and fully comprehend the document; (b) identify the core idea that a non-specialist audience needs to understand; and (c) produce an annotated script for a 90-second public explainer.</li> <li><b>Cross-Disciplinary Case Analysis and Defence</b> (Group): Groups of 3–4 students select one</li> </ol> |                                       |                                 |                                                           |                    |

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| <p>case from a faculty-curated shortlist of five to six approved cases. The group delivers a 10-minute structured presentation that goes beyond narrative description - identify the specific communication failures, explain the ethical or regulatory dimensions of those failures, and propose what a communication-competent response would have looked like. This is followed immediately by a 5-minute live Q&amp;A in which individual group members must defend their analytical assertions against probing questions from both faculty and peers.</p>                                                                                                                                                                                                                                                                                                                                                                                                                       |                                               |
| <b>Text Book(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                               |
| 1. Markel, M., & Selber, S. A. (2021). <i>Technical Communication</i> (13th ed.). Bedford/St. Martin's.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                               |
| <b>Reference Book(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                               |
| <p>R1. Carnegie, D. (1936/1998). <i>How to Win Friends and Influence People</i>. Simon &amp; Schuster.<br/> R2. Orwell, G. (1946). <i>Politics and the English Language</i>.<br/> R3. Strunk, W., &amp; White, E. B. (1999). <i>The Elements of Style</i> (4th ed.). Longman.<br/> R4. Kahneman, D. (2011). <i>Thinking, Fast and Slow</i>. Farrar, Straus and Giroux.<br/> R5. O'Neil, C. (2016). <i>Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy</i>. Crown Publishers.<br/> R6. Adler, R. B., Rodman, G., &amp; DuPré, A. (2019). <i>Understanding Human Communication</i> (14th ed.). Oxford University Press.</p>                                                                                                                                                                                                                                                                                                                     |                                               |
| <b>Web Sources:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                               |
| <ul style="list-style-type: none"> <li>• owl.purdue.edu</li> <li>• plainlanguage.gov</li> <li>• allsides.com</li> <li>• adfontesmedia.com</li> <li>• ted.com</li> <li>• economist.com/styleguide</li> <li>• factcheck.org</li> <li>• ailiteracy.org</li> <li>• learnprompting.org</li> <li>• unesco.org/en/artificial-intelligence/ethics</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                               |
| <p><b>Topics relevant to "SKILL DEVELOPMENT":</b> Active listening, verbal and non-verbal communication, interpersonal communication and self-awareness, elements of spoken communication — voice, clarity, and presence, storytelling and narrative in spoken contexts, structuring spoken messages, speaking with confidence, group communication and productive disagreement, giving and receiving feedback, presentation design and delivery, speaking for technical and non-technical audiences, critical reading, identifying tone and bias, understanding flawed reasoning, source credibility and information evaluation, reading multimodal texts, principles of effective writing, plain language and technical communication, professional writing — email, reports, and correspondence, argumentative writing, summary writing, prompt engineering, AI-assisted writing, ethical AI use in academic and professional communication, AI bias and critical evaluation.</p> |                                               |
| <b>Catalogue prepared by</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Dr Ajith K and Dr Shahanas Punnilath Shanavas |
| <b>Recommended by the Board of Studies on</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                               |
| <b>Date of</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                               |

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| <b>Approval by the Academic Council</b> |  |
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| Course Code:<br>CSS1500                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Course Title: Computational Thinking using Python<br>Type of Course: Lab Integrated Course (ESC)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | L-T-P-C    | 2-0-2-3 |
| Version No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |            |         |
| Course Pre-requisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Nil                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |            |         |
| Anti-requisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |            |         |
| Course Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | This course efficiently introduces fundamental programming concepts including conditionals, loops, functions, lists, strings, tuples, and dictionaries through practical examples and problem-solving techniques. It also covers advanced programming concepts such as exception handling, file processing, modules, and packages using Python. The course emphasizes computational thinking, algorithm development, and implementation of searching and sorting techniques using Python data structures. Additionally, it introduces secure file handling, intelligent input validation, and AI-assisted data processing concepts for real-world applications.                                                                             |            |         |
| Course Objective                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | To develop computational thinking and problem-solving skills using Python by enabling students to design algorithms, implement programs using core programming constructs, apply data structures and file handling techniques, and develop secure and intelligent solutions for real-world applications.                                                                                                                                                                                                                                                                                                                                                                                                                                    |            |         |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | On successful completion of this course, students will be able to:<br>CO1: Apply computational thinkingUnderstand principles to design algorithms for solving basic and intermediate computing problems.<br>CO2: Implement Python programs usingApply data types, operators, and expressions to perform computational tasks.<br>CO3: Develop programs using controlApply structures, functions, and recursion to solve structured problems.<br>CO4: Utilize data structures such as lists,Apply tuples, and dictionaries for efficient data representation and manipulation.<br>CO5: Design and implement PythonApply programs for secure file handling, exception management, and intelligent data validation for real-world applications. |            |         |
| Course Content:                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |            |         |
| Module 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Computational Thinking And Problem Solving                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 6 Sessions |         |
| <u>Topics:</u><br>Fundamentals of Computing– Identification of Computational Problems Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |            |         |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Datatypes, Expressions, Statements                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 6 Sessions |         |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                         |                    |
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| <b>Topics:</b><br>Python interpreter and interactive mode,debugging; values and types: int, float, boolean, string , and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.                                                                                                                                                                 |                                         |                    |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Control flow, Functions, Strings</b> | <b>6 Sessions</b>  |
| <b>Topics:</b><br>Conditionals:Boolean values and operators, conditional (if), alternative (if else),chained conditional (if-elif-else);Iteration: state, while, for, break, continue, pass; Fruitful functions: return values,parameters, local and global scope, function composition, recursion; Strings: string slices,immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search. |                                         |                    |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Lists, Tuples, Dictionaries</b>      | <b>6 Sessions</b>  |
| <b>Topics:</b><br>Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing- list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.                                                                                                                                        |                                         |                    |
| <b>Module 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Files</b>                            | <b>6 Sessions</b>  |
| Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100), Secure File Handling, Intelligent Error Detection using AI Concepts, Smart Input Validation Techniques, Automated Data Validation Applications.                                                                                             |                                         |                    |
| <b>List of Practical Tasks</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                         | <b>30 Sessions</b> |
| <b>WEEK 1: Computational Thinking &amp; Algorithms</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                         |                    |
| <b>Lab Sheet 1: Problem Solving &amp; Algorithm Design</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                         |                    |
| <b>Level 1:</b> Write an algorithm and Python program to find the minimum element in a list of numbers.                                                                                                                                                                                                                                                                                                                                                                                                                |                                         |                    |
| <b>Level 2:</b> Write an algorithm and Python program to insert an element into a sorted list at the correct position.                                                                                                                                                                                                                                                                                                                                                                                                 |                                         |                    |
| <b>Lab Sheet 2: Algorithm Strategies (Iteration &amp; Recursion)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                         |                    |
| <b>Level 1:</b> Write a Python program to guess a number within a given range using iteration.                                                                                                                                                                                                                                                                                                                                                                                                                         |                                         |                    |
| <b>Level 2:</b> Write a Python program to solve the Tower of Hanoi problem using recursion.                                                                                                                                                                                                                                                                                                                                                                                                                            |                                         |                    |
| <b>WEEK 2: Data Types &amp; Expressions</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                         |                    |
| <b>Lab Sheet 3: Data Types &amp; Variables</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                         |                    |
| <b>Level 1:</b> Write a Python program to demonstrate different data types (int, float, boolean, string, list).                                                                                                                                                                                                                                                                                                                                                                                                        |                                         |                    |
| <b>Level 2:</b> Write a Python program to perform type conversions and display results.                                                                                                                                                                                                                                                                                                                                                                                                                                |                                         |                    |
| <b>Lab Sheet 4: Expressions &amp; Operators</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                         |                    |
| <b>Level 1:</b> Write a Python program to swap two variables using tuple assignment.                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                         |                    |
| <b>Level 2:</b> Write a Python program to circulate the values of n variables.                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                         |                    |
| <b>WEEK 3: Expressions &amp; Problem Solving</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                         |                    |
| <b>Lab Sheet 5: Mathematical Expressions</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                         |                    |
| <b>Level 1:</b> Write a Python program to calculate the distance between two points.                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                         |                    |
| <b>Level 2:</b> Write a Python program to evaluate complex arithmetic expressions with operator precedence.                                                                                                                                                                                                                                                                                                                                                                                                            |                                         |                    |
| <b>Lab Sheet 6: Debugging &amp; Interactive Mode</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                         |                    |
| <b>Level 1:</b> Write a Python program with intentional errors and debug it.                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                         |                    |
| <b>Level 2:</b> Write a Python program to demonstrate interactive mode operations.                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                         |                    |
| <b>WEEK 4: Conditional Statements</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                         |                    |
| <b>Lab Sheet 7: Decision Making</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                         |                    |
| <b>Level 1:</b> Write a Python program to check whether a number is positive, negative, or zero.                                                                                                                                                                                                                                                                                                                                                                                                                       |                                         |                    |
| <b>Level 2:</b> Write a Python program to find the largest of three numbers using if-elif-else.                                                                                                                                                                                                                                                                                                                                                                                                                        |                                         |                    |
| <b>Lab Sheet 8: Advanced Conditions</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                         |                    |
| <b>Level 1:</b> Write a Python program to check whether a number is even or odd.                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                         |                    |

**Level 2:** Write a Python program to implement a grading system using chained conditions.

### **WEEK 5: Iteration (Loops)**

#### **Lab Sheet 9: Looping Basics**

**Level 1:** Write a Python program to print numbers from 1 to N using a loop.

**Level 2:** Write a Python program to compute factorial using loops.

#### **Lab Sheet 10: Loop Control**

**Level 1:** Write a Python program demonstrating break and continue.

**Level 2:** Write a Python program to generate number patterns using nested loops.

### **WEEK 6: Functions**

#### **Lab Sheet 11: Functions Basics**

**Level 1:** Write a Python function to calculate square root of a number.

**Level 2:** Write a Python function to find GCD of two numbers.

#### **Lab Sheet 12: Recursion & Scope**

**Level 1:** Write a recursive function to calculate exponentiation.

**Level 2:** Write a Python program demonstrating local and global variables.

### **WEEK 7: Strings**

#### **Lab Sheet 13: String Operations**

**Level 1:** Write a Python program to demonstrate string slicing.

**Level 2:** Write a Python program to check whether a string is a palindrome.

#### **Lab Sheet 14: String Methods**

**Level 1:** Write a Python program using string functions (upper, lower, replace).

**Level 2:** Write a Python program to count vowels and consonants in a string.

### **WEEK 8: Lists**

#### **Lab Sheet 15: List Basics**

**Level 1:** Write a Python program to create and display a list.

**Level 2:** Write a Python program to find the sum of elements in a list.

#### **Lab Sheet 16: List Operations**

**Level 1:** Write a Python program to demonstrate list slicing.

**Level 2:** Write a Python program to perform linear search on a list.

### **WEEK 9: Advanced Lists**

#### **Lab Sheet 17: List Methods**

**Level 1:** Write a Python program to demonstrate list methods (append, remove).

**Level 2:** Write a Python program to sort a list.

#### **Lab Sheet 18: List Comprehension**

**Level 1:** Write a Python program using list comprehension to generate squares.

**Level 2:** Write a Python program to create a histogram of list values.

### **WEEK 10: Tuples**

#### **Lab Sheet 19: Tuple Basics**

**Level 1:** Write a Python program to create and access tuple elements.

**Level 2:** Write a Python program to demonstrate tuple assignment.

#### **Lab Sheet 20: Tuples as Return Values**

**Level 1:** Write a Python function returning multiple values using tuple.

**Level 2:** Write a Python program to swap values using tuples.

### **WEEK 11: Dictionaries**

#### **Lab Sheet 21: Dictionary Basics**

**Level 1:** Write a Python program to create and access dictionary elements.

**Level 2:** Write a Python program to count frequency of elements using dictionary.

#### **Lab Sheet 22: Dictionary Applications**

**Level 1:** Write a Python program to store student marks using dictionary.

**Level 2:** Write a Python program to generate a retail bill using dictionary.

### **WEEK 12: Advanced List Processing**

#### **Lab Sheet 23: Sorting & Searching**

**Level 1:** Write a Python program to implement simple sorting.

**Level 2:** Write a Python program to implement binary search.

#### **Lab Sheet 24: Data Processing**

**Level 1:** Write a Python program to generate student marks statement.

**Level 2:** Write a Python program to analyze list data (min, max, average).

### **WEEK 13: File Handling Basics**

#### **Lab Sheet 25: File Operations**

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| <p><b>Level 1:</b> Write a Python program to create and write to a text file.</p> <p><b>Level 2:</b> Write a Python program to read and display file contents.</p> <p><b>Lab Sheet 26: File Processing</b></p> <p><b>Level 1:</b> Write a Python program to count words in a file.</p> <p><b>Level 2:</b> Write a Python program to copy contents from one file to another.</p> <p><b>WEEK 14: Exceptions &amp; Validation</b></p> <p><b>Lab Sheet 27: Exception Handling</b></p> <p><b>Level 1:</b> Write a Python program using try-except.</p> <p><b>Level 2:</b> Write a Python program to handle multiple exceptions.</p> <p><b>Lab Sheet 28: Validation Programs</b></p> <p><b>Level 1:</b> Write a Python program to validate voter's age.</p> <p><b>Level 2:</b> Write a Python program to validate marks range (0–100).</p> <p><b>WEEK 15: Modules &amp; Advanced Concepts</b></p> <p><b>Lab Sheet 29: Modules &amp; Packages</b></p> <p><b>Level 1:</b> Write a Python program to create and use a module.</p> <p><b>Level 2:</b> Write a Python program to use built-in modules.</p> <p><b>Lab Sheet 30: Command Line Arguments</b></p> <p><b>Level 1:</b> Write a Python program to accept command-line arguments.</p> <p><b>Level 2:</b> Write a Python program to perform operations using command-line inputs</p> <p><b>WEEK 15.1: Secure and Intelligent Python Applications</b></p> <p><b>Lab Sheet 31: Secure File Handling and Validation</b></p> <p><b>Level 1:</b> Write a Python program for secure file reading and writing with exception handling.</p> <p><b>Level 2:</b> Implement intelligent input validation for user data using exception handling techniques.</p> <p><b>Lab Sheet 32: AI-based Python Applications</b></p> <p><b>Level 1:</b> Develop a Python program for automated data validation or log analysis.</p> <p><b>Level 2:</b> Implement a simple intelligent application using Python modules and file processing concepts.</p> <p><b>Project work/Assignment:</b></p> <ol style="list-style-type: none"> <li>Assignment 1 on (Module 1 and Module 2)</li> <li>Assignment 2 on (Module 3 and Module 4 &amp; 5)</li> </ol> <p><b>Text Book</b></p> <ol style="list-style-type: none"> <li>Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021</li> <li>Eric Matthes, Python Crash Course,: A Hands-On, Project-Based Introduction to Programming, 3rd Edition, 2023</li> </ol> <p><b>References</b></p> <ol style="list-style-type: none"> <li>Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.</li> <li>Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning &amp; Development Limited, 2017.</li> </ol> <p><b>Web Resources</b></p> <ol style="list-style-type: none"> <li><a href="https://onlinecourses.nptel.ac.in/noc20_cs70/preview">https://onlinecourses.nptel.ac.in/noc20_cs70/preview</a></li> <li><b>Topics relevant to development of "Employability":</b> Data structures using python.</li> <li><b>Topics relevant to "PROFESSIONAL ETHICS":</b> Naming and coding convention for simple programs using python.</li> </ol> |
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|-------------------------|--------------------------------------------------------------|-----------|---------|
| Course Code:<br>ECE2022 | Course Name: Digital Design<br>Type of Course: Theory Course | L- T-P- C | 2-0-0-2 |
| Version No.             | 1.0                                                          |           |         |
| Course Pre-requisites   | NIL                                                          |           |         |
| Co-requisites           | ECE2052                                                      |           |         |
| Anti-requisites         | NIL                                                          |           |         |

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| Course Description                                                                                                                                                                                                                                                                                                                                   | The purpose of this course is to enable the students to appreciate the fundamentals of digital logic circuits and Boolean algebra. Further to focusing on combinational and sequential digital logic circuits. This course is analytical in nature and needs a fundamental knowledge on logical computation with Boolean algebra. The focus of the course will be to discuss the minimization techniques for making low-cost canonical digital circuit implementations. In this course, we emphasize design procedures of digital electronic circuits.<br>Additionally, this course will create a foundation for future courses that includes Computer Architecture, Microprocessors, Microcontrollers and Embedded Systems etc. |            |             |
| Course Objective                                                                                                                                                                                                                                                                                                                                     | The objective of the course is to familiarize the learners with Design and Analysis of Digital Logic Circuits concepts and to improve the learner's SKILL DEVELOPMENT by using PARTICIPATIVE LEARNING TECHNIQUES through Assessments.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |            |             |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                      | On successful completion of this course the students shall be able to:<br>CO1. Explain the fundamental concepts of Number system, Boolean algebra and Logic gates<br>CO2. Determine the minimum literal Boolean Expression using K-Map minimization techniques<br>CO3. Make use of relevant logic gates for constructing the combinational circuit.<br>CO4. Produce standard and real world combinational logic circuits using minimum number of logic gates<br>CO5. Demonstrate the working principles of flip-flops and latches within the context of sequential logic circuits.<br>CO6. Design synchronous and asynchronous logic circuit using Flip-flops                                                                    |            |             |
| Course Content:                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |            |             |
| Module 1                                                                                                                                                                                                                                                                                                                                             | Number System, Logic Gates & Boolean function simplification ( Comprehension Level)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Assessment | 10 Sessions |
| Topics:<br>Review of Number systems -Overview of Boolean Algebra- Boolean Laws, Rules & Theorems. Boolean function Standard form and Canonical form. Review of logic gates -Basic gates, Universal gates & Special Gates- Boolean functions simplifications using Algebraic functions & Karnaugh-map. SOP and POS simplifications & Implementations. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |            |             |
| Module 2                                                                                                                                                                                                                                                                                                                                             | Combinational Logic circuits: ( Application Level)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Assessment | 10 Sessions |
| Topics:<br>Digital logic circuit Introduction –Classification of circuit- Analysis and Design procedure of Combinational Logic circuits - Binary Adder and Subtractor- Magnitude comparator- , Multiplexers - DeMultiplexers, Decoders, Encoders and Priority Encoders-Real world scenario based application design using logic gates.               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |            |             |
| Module 3                                                                                                                                                                                                                                                                                                                                             | Sequential logic circuits (Application Level)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Quiz       | 10 Sessions |
| Topics:<br>Introduction to sequential circuits- Storage elements: latches and flip flops- Characteristic tables and equations, excitation table- Analysis of clocked sequential circuits- state diagram-state table and design of finite state machines - Registers & Counters.                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |            |             |
| Text Book<br>T1: Thomas L Flyod, “Digital Fundamentals”, Eleventh Edition, Pearson Education. ISBN-10: 132737965. (2014).eBook-[PDF] DIGITAL LOGIC DESIGN FOURTH EDITION FLOYD   abri.engenderhealth.org                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |            |             |

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| T2: Mano, M. Morris and Ciletti Michael D., "Digital Design", Pearson Education, 6th edition<br>., [PDF] Digital Design By M. Morris Mano, Michael D Ciletti Book Free Download (studymaterialz.in)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <p>References</p> <p>R1: Jain, R. P., "Modern Digital Electronics", McGraw Hill Education (India).</p> <p>R2: Roth, Charles H., Jr and Kinney Larry L., "Fundamentals of logic Design", Cengage Learning</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <p>E-Resources/Web Resources</p> <ol style="list-style-type: none"> <li>1. <a href="https://openFullText.html?DP=https://nptel.ac.in/courses/108105132">https://openFullText.html?DP=https://nptel.ac.in/courses/108105132</a></li> <li>2. <a href="https://openFullText.html?DP=https://ocw.mit.edu/courses/6-111-introductory-digital-systems-laboratory-fall-2006/">https://openFullText.html?DP=https://ocw.mit.edu/courses/6-111-introductory-digital-systems-laboratory-fall-2006/</a></li> <li>3. <a href="https://openFullText.html?DP=https://www.javatpoint.com/digital-electronics">https://openFullText.html?DP=https://www.javatpoint.com/digital-electronics</a></li> <li>4. <a href="https://openFullText.html?DP=https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/">https://openFullText.html?DP=https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/</a></li> <li>5. <a href="https://openFullText.html?DP=https://circuitverse.org">https://openFullText.html?DP=https://circuitverse.org</a></li> </ol> |

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| <b>Course Code: ECE1512</b>  | <b>Course Title: Design Thinking in Practice</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>L- T-P-2</b> | <b>0</b> | <b>2</b> | <b>3</b> |
| <b>Version No.</b>           | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                 |          |          |          |
| <b>Course Pre-requisites</b> | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                 |          |          |          |
| <b>Anti-requisites</b>       | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                 |          |          |          |
| <b>Course Description</b>    | <p>This course introduces students to Design Thinking frameworks for identifying real-world user needs and transforming them into innovative technology solutions using embedded systems, sensors, IoT platforms, and AI-enabled computing devices. The course blends human-centered innovation methodologies with hands-on development using Arduino, Aries, ESP32, Raspberry Pi, NVIDIA Jetson, and GPU-based embedded platforms. Students will develop problem-solving skills while learning problem identification, ideation, rapid prototyping, sensor integration, edge AI, and intelligent system development for applications in smart automation, healthcare, agriculture, robotics, and Industry 5.0. The course emphasizes experiential and project-based learning to build future-ready innovators capable of developing scalable, intelligent, and socially impactful products.</p> |                 |          |          |          |
| <b>Course Objective</b>      | <p><b>The object of the course is to enhance students' employability skills through participative learning techniques</b> by integrating Design Thinking, embedded systems, IoT, and AI technologies to develop innovative, intelligent, and socially impactful real-world solutions.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |          |          |          |

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| Course Outcomes                                                                                                                                                                                                                                                                                                                                                    | On successful completion of the course, the students shall be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |
|                                                                                                                                                                                                                                                                                                                                                                    | <div>1. <b>Explain</b> the principles, framework, and process of design thinking</div> <div>2. <b>Formulate</b> Engineering Problem from user challenges, customer expectations, and market opportunities using design thinking process.</div> <div>3. <b>Analyze</b> the Engineering Problem using the basic concepts of microcontroller and sensory devices.</div> <div>4. <b>Find</b> alternate methods to solve the engineering problem by working with embedded computing platforms.</div> <div>5. <b>Develop</b> functional prototypes using embedded boards, sensors, and an intelligent system for the chosen method</div> <div>6. <b>Validate</b> prototype performance through testing, user feedback, and iterative improvements.</div> |            |
| Course Content                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            |
| Module 1                                                                                                                                                                                                                                                                                                                                                           | Introduction to Design Thinking                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 6 Sessions |
| -----Introduction to Design Thinking Importance of Design Thinking History of Design Thinking- Design Thinking Framework - Design Thinking process - Empathise Define Understanding Purpose - Ideate - What is Creativity? -Thinking Differently Basic Rules of Design Thinking The Creativity Heart Set Everyone is a Designer - Activity-based with case studies |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            |
| Basic concepts of Microcontrollers and sensory devices                                                                                                                                                                                                                                                                                                             | 8 sessions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |            |
| Working with embedded computing platforms and 3D printing technology                                                                                                                                                                                                                                                                                               | 8 sessions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |            |
| Prototype development and validation techniques                                                                                                                                                                                                                                                                                                                    | 8 sessions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |            |
| Dr. Divyarani M S, Dr. M Manikandan                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            |
| BoS Number:                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            |
| Academic Council Meeting No. dated on                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            |

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| Course Code:<br>PHY2504 | Course Title: Optoelectronics and Quantum Physics Lab<br>Type of Course: 1] School Core | L-T-P-C | 0-0-2-1 |
| Version No.             | 1.0                                                                                     |         |         |
| Course Pre-requisites   | NIL                                                                                     |         |         |
| Anti-requisites         | NIL                                                                                     |         |         |

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| Course Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | The laboratory provides an opportunity to validate the concepts taught and enhances the ability to use the concepts for technological applications. The laboratory tasks aim to develop following skills: An attitude of enquiry, confidence and ability to tackle new problems, ability to interpret events and results, observe and measure physical phenomena, select suitable equipment, instrument and materials, locate faults in systems. |
| Course Out Comes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | On successful completion of the course the students shall be able to:<br><b>CO1:</b> Understand electrical and optical properties ofLevel 2 – Understand materials.<br><b>CO2:</b> Interpret the results of various experiments toLevel 2 – Understand verify the concepts used in optoelectronics and advanced devices.                                                                                                                         |
| Course Objective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | The objective of the course is to familiarize the learners with the concepts of “Applied Physics for Computer Science Cluster ”and attain Skill Development through Experiential Learning techniques                                                                                                                                                                                                                                             |
| List of Laboratory Tasks:<br>Experiment No. 1: Experimental errors and uncertainty using excel<br>Level 1: Calculation of accuracy and precision of a given data<br>Level 2: propagation of errors in addition, subtraction, multiplication and division.<br><br>Experiment NO 2: To determine the wavelength of semiconductor diode Laser and to estimate the particle size of lycopodium powder using diffraction.<br>Level 1: Determination of Wavelength of Laser<br>Level 2: Finding the particle size of lycopodium powder.<br><br>Experiment No. 3: To determine the proportionality of Hall Voltage, magnetic flux density and the polarity of Charge carrier.<br>Level 1: To determine the proportionality of Hall Voltage and magnetic flux density<br>Level 2: To determine the polarity of Charge carrier.<br><br>Experiment No. 4: To study the I-V characteristics of a given zener diode in forward and reverse bias conditions.<br>Level 1: To study I –V characteristics of the given Zener diode in reverse bias and to determine break down voltage.<br>Level 2: To study I –V characteristics of the given Zener diode in forward bias and to determine knee voltage and forward resistance.<br><br>Experiment No. 5: To study input and output characteristics of a given Transistor.<br>Level 1: To determine the input resistance of a given transistor.<br>Level 2: To determine current transfer characteristics and transistor parameters of a given transistor.<br><br>Experiment No. 6: Determination of Fermi energy and Fermi temperature of a given metal and bimetallic wire.<br><br>Level 1: Determination of Fermi energy and Fermi temperature of given metal wire.<br>Level 2: Determination of Fermi energy and Fermi temperature of given bimetallic wire.<br><br>Experiment No. 7: To study the I-V characteristics and I-R characteristics of a solar cell as a function of the irradiance.<br>Level 1: To study the I-V characteristics<br>Level 2: I-R characteristics of a solar cell as a function of the irradiance. |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

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| Experiment No. 8: Calculate the numerical aperture and study the losses that occur in optical fiber cable.<br>Level 1: Calculate the numerical aperture.<br>Level 2: study the losses that occur in optical fiber cable.                                                                                                                                                                                                     |
| Experiment No. 9: Plotting I-V characteristics in forward and reverse bias for LEDs and Determination of knee voltage.<br>Level 1: Plotting I-V characteristics in forward and reverse bias for LEDs<br>Level 2: Determination of knee voltage.                                                                                                                                                                              |
| Experiment No. 10: Determination of Stefan's constant and verification of Stefan-Boltzmann Law.<br>Level 1: Determination of Stefan's constant<br>Level 2: Verification of Stefan-Boltzmann Law.                                                                                                                                                                                                                             |
| Experiment No. 11: : Dielectric constant<br>Level 1: Determination of Dielectric constant of given material<br>Level 2: compare the obtain results with other materials                                                                                                                                                                                                                                                      |
| Experiment No. 12: determine the wavelength of monochromatic light, such as sodium light, using Newton's rings.<br>Level 1: Determination of wavelength<br>Level 2: determine the radius of curvature of the Plano-convex lens.                                                                                                                                                                                              |
| Targeted Application & Tools that can be used:<br>Areas of application are optoelectronics industry, Solar panel technologies, quantum computing software, electronic devices using transistors and diodes, memory devices, endoscopy, SQUIDS in MRI, Advanced material characterizations using SEM and STM.<br>Origin, excel and Mat lab soft wares for programming and data analysis.                                      |
| Project work/Assignment: Mention the Type of Project /Assignment proposed for this course                                                                                                                                                                                                                                                                                                                                    |
| Assessment Type<br>Midterm exam<br>Assignment (review of digital/ e-resource from PU link given in references section - mandatory to submit screen shot accessing digital resource.)<br>Quiz<br>End Term Exam<br>Self-Learning<br>1. Prepare a comprehensive report on non-conventional energy resources in Karnataka and their pros and cons.<br>2. Write a report on importance of quantum entanglement in supercomputers. |

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| Course Code:<br>PPS1025 | Course Title: Industry Readiness Program – I<br>Type of Course: Practical Only Course                                                                                                                                                                                                    | L-T- P - C | 0 | 0 | 2 | 0 |
| Version No.             | 1.0                                                                                                                                                                                                                                                                                      |            |   |   |   |   |
| Course Pre-requisites   | Students are expected to understand basic English.<br>Students should have desire and enthusiasm to involve, participate and learn.                                                                                                                                                      |            |   |   |   |   |
| Anti-requisites         | NIL                                                                                                                                                                                                                                                                                      |            |   |   |   |   |
| Course Description      | This course is designed to enable students to set SMART goals, form professional & personal ethics for success, and learn various email writing techniques. The course will benefit learners in presenting themselves effectively through various activities and learning methodologies. |            |   |   |   |   |

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| Course Objective                                                                                                                                              | The objective of the course is to familiarize the learners with the concepts of “Employability for Young Professionals” and attain SKILL DEVELOPMENT through PARTICIPATIVE LEARNING techniques.                                                                                                        |                                   |             |
| Course Outcomes                                                                                                                                               | On successful completion of the course the students shall be able to:<br><b>CO1:</b> Define their career goals [Level 1 - Remember]<br><b>CO2:</b> Practice ethical habits for better career success [Level 3 - Apply]<br><b>CO3:</b> Demonstrate effective email writing techniques [Level 3 - Apply] |                                   |             |
| Course Content:                                                                                                                                               |                                                                                                                                                                                                                                                                                                        |                                   |             |
| Module 1                                                                                                                                                      | Goal Setting & Grooming                                                                                                                                                                                                                                                                                | Classroom activities              | 10 Sessions |
| Topics: SMART Goals, formal grooming through self-introduction activity<br>Activity: Real world scenarios                                                     |                                                                                                                                                                                                                                                                                                        |                                   |             |
| Module 2                                                                                                                                                      | Habit Formation                                                                                                                                                                                                                                                                                        | Role plays                        | 10 Sessions |
| Topics: Professional and Personal ethics for success and activity-based practice<br>Activity: Students to present 2 min video on building professional ethics |                                                                                                                                                                                                                                                                                                        |                                   |             |
| Module 3                                                                                                                                                      | Email Etiquettes                                                                                                                                                                                                                                                                                       | Individual and group presentation | 10 Sessions |
| Topics: Types of prompts to generate effective or desired results for email etiquettes<br>Activity: Individual student presenting various search prompts      |                                                                                                                                                                                                                                                                                                        |                                   |             |
| Targeted Applications & Tools:<br>TED Talks; You Tube Links; Activities                                                                                       |                                                                                                                                                                                                                                                                                                        |                                   |             |
| Assignment proposed for this course<br>Assignment 1: SMART Goal<br>Assignment 2: AI tools for prompt search                                                   |                                                                                                                                                                                                                                                                                                        |                                   |             |
| Continuous Individual Assessment<br>Module 1: Presentation<br>Module 2: Activity based assessment<br>Module 3: Class assessment                               |                                                                                                                                                                                                                                                                                                        |                                   |             |

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| Course Code:<br>ECE2052 | Course Name: Digital Design Lab<br>Type of Course: Laboratory Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | L- T-P- C | 0-0-2-1 |
| Version No.             | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |         |
| Course Pre-requisites   | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |         |
| Co-requisites           | ECE2022                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           |         |
| Anti-requisites         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |         |
| Course Description      | This course gives knowledge through the simulation software for design and implementation of various digital logic circuit. The theoretical concepts and working principles of combinational and sequential logic circuits are verified through implementation using openCV. This course provides necessary learning for fundamental concepts of computer and communication engineering. The purpose of this course is to support the students to exhibit the design and analysis skills.<br>The course enhances the Design and Implementation abilities through laboratory tasks. Additionally, it provides an opportunity to verify the theoretical knowledge. |           |         |
| Course Objective        | The objective of the course is to familiarize the learners with the design concepts of digital logic circuit and attain Skill Development through Experiential Learning by simulation-based laboratory Assessments.                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |         |
| Course Outcomes         | On successful completion of the course the students shall be able to<br>CO1. Interpret Boolean laws and the logic gates functionality using available circuit elements in simulator platforms.<br>CO2. Apply the fundamental laws and rules of Boolean algebra for simplified circuit                                                                                                                                                                                                                                                                                                                                                                            |           |         |

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| Course Content:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>List of Laboratory Tasks:</b> <ul style="list-style-type: none"> <li>• <b>Experiment 1: Logic Gates.</b><br/>Study and verify the operation of basic logic gates such as AND, OR, NOT, NAND, NOR, XOR, and XNOR.</li> <li>• <b>Experiment 2: Boolean Algebra</b><br/>Implement and verify Boolean algebra laws and simplification techniques using logic circuits.</li> <li>• <b>Experiment 3: Adder</b><br/>Design and analyze half adder and full adder circuits for binary addition.</li> <li>• <b>Experiment 4: Subtractor</b><br/>Design and verify half subtractor and full subtractor circuits for binary subtraction.</li> <li>• <b>Experiment 5: Magnitude Comparator</b><br/>Design a circuit to compare two binary numbers and determine equality or greater/less conditions.</li> <li>• <b>Experiment 6: Design of Combinational Circuits</b><br/>Design and implement combinational logic circuits using Boolean expressions and K-maps.</li> <li>• <b>Experiment 7: Multiplexer, Demultiplexer &amp; Applications of MUX</b><br/>Study the working of multiplexers and demultiplexers and implement logic functions using MUX.</li> <li>• <b>Experiment 8: Flip-Flops</b><br/>Implement and verify the operation of SR, JK, D, and T flip-flops.</li> <li>• <b>Experiment 9: Shift Registers</b><br/>Design and analyze serial and parallel shift registers for data storage and transfer.</li> <li>• <b>Experiment 10: Counter Design</b><br/>Design and implement synchronous and asynchronous counters using flip-flops.</li> </ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Targeted Applications & Tools:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| CIRCUIT VERSE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | An online digital circuit simulation platform used for designing and testing logic circuits and combinational/sequential circuits.                                                                                                                                                                                                                                                                                                                                                          |
| HDL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Hardware Description Language used to model, design, and simulate digital electronic systems and circuits.                                                                                                                                                                                                                                                                                                                                                                                  |
| VHDL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Very High-Speed Integrated Circuit Hardware Description Language used for designing, simulating, and implementing digital systems in FPGA and ASIC design.                                                                                                                                                                                                                                                                                                                                  |
| Skill-Building Activities through Experiential Learning:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <ul style="list-style-type: none"> <li>• Design and simulation of digital circuits using CircuitVerse/HDL tools.</li> <li>• Hands-on implementation of combinational and sequential circuits.</li> <li>• Mini exercises on logic simplification and circuit optimization.</li> <li>• Team-based circuit design and debugging activities.</li> <li>• Real-time verification of flip-flops, counters, and shift registers.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Text Book                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>T1:</b> Mano, M. Morris and Ciletti Michael D., "Digital Design", Pearson Education, 6th edition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>T2:</b> Thomas L. Floyd "DIGITAL LOGIC DESIGN", Pearson Education, fourth edition.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

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| References                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| R1: Jain, R. P., “Modern Digital Electronics”, McGraw Hill Education (India), Fourth Edition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| R2: Roth, Charles H., Jr and Kinney Larry L., “Fundamentals of logic Design”, Cengage Learning, Seventh Edition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| E-Resources/Web Resources                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <ol style="list-style-type: none"> <li>1. <a href="https://circuitverse.org/">https://circuitverse.org/</a></li> <li>2. <a href="https://ocw.mit.edu/courses/6-111-introductory-digital-systems-laboratory-fall-2006/">https://ocw.mit.edu/courses/6-111-introductory-digital-systems-laboratory-fall-2006/</a></li> <li>3. <a href="https://nptel.ac.in/courses/108105132">https://nptel.ac.in/courses/108105132</a></li> <li>4. <a href="https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/">https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/</a></li> <li>5. <a href="https://www.tutorialspoint.com/digital_electronics/index.htm">https://www.tutorialspoint.com/digital_electronics/index.htm</a></li> <li>6. <a href="https://github.com/logisim-evolution/logisim-evolution">https://github.com/logisim-evolution/logisim-evolution</a></li> <li>7. <a href="https://www.javatpoint.com/digital-electronics">https://www.javatpoint.com/digital-electronics</a></li> </ol> |

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| <b>Course Code:</b><br>MAT1212 | <b>Course Title:</b> Mathematical foundations for Machine Learning and Data Analysis<br><b>Type of Course:</b> 1] School Core                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>- P - C</b> | 3 | 1 | 0 | 4 |
| <b>Version No.</b>             | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                |   |   |   |   |
| <b>Course Pre-requisites</b>   | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                |   |   |   |   |
| <b>Anti-requisites</b>         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                |   |   |   |   |
| <b>Course Description</b>      | This course provides a comprehensive foundation in advanced mathematical concepts essential for engineering and scientific applications. It covers integral calculus and special functions, linear transformations and matrix decompositions, vector spaces and inner product spaces, and probability theory with random variables and standard probability distributions. The course emphasizes mathematical modeling, analytical problem-solving, data analysis techniques, and engineering applications, enabling students to apply mathematical tools to solve real-world engineering problems.                                                                                                                                                                                                  |                |   |   |   |   |
| <b>Course Objective</b>        | The course aims to develop a strong conceptual understanding of vector spaces, linear algebra, and vector calculus. It introduces mathematical techniques used in engineering analysis and modelling, enabling students to apply these concepts effectively in solving engineering problems. The course also enables students to apply probability distributions and statistical methods in practical situations involving uncertainty and data analysis. Further, it strengthens analytical and problem-solving skills through applications of differential equations and statistical inference. In addition, the course familiarizes students with computational tools for solving engineering mathematics problems, thereby enhancing their ability to address real-world engineering challenges. |                |   |   |   |   |
| <b>Course Outcomes</b>         | On successful completion of the course the students shall be able to:<br><b>C01:</b> Apply integral calculus and special functions to solve engineering problems. (L3)<br><b>C02:</b> Solve problems involving linear transformations and matrix techniques. (L3)<br><b>C03:</b> Apply concepts of vector spaces, basis, dimension, and orthogonality in mathematical applications. (L3)<br><b>C04:</b> Apply probability concepts and random variable distributions to solve problems involving uncertainty and stochastic phenomena (L3)<br><b>C05:</b> Examine discrete and continuous random variables using probability distributions such as Binomial, Poisson, Uniform, Exponential, and Normal                                                                                               |                |   |   |   |   |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | distributions. (L3)<br><b>CO6:</b> Utilize computational tools such as MATLAB, Python, or similar software for mathematical computation, data analysis, and engineering applications. (L3) |                              |
| <b>Course Content:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                            |                              |
| <b>Module 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Integral Calculus and Special Functions</b>                                                                                                                                             | <b>(8L+3T=11 Sessions)</b>   |
| Definite and indefinite integrals, Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Surface areas, volumes, Sterlin approximation theorem.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                            |                              |
| <b>Module 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Vector Spaces and Inner Product Spaces</b>                                                                                                                                              | <b>(12L+4T=16 Sessions)</b>  |
| Vector Space, Examples, Properties, Subspaces, Linear Combinations, Spanning Set of a Vector Space, Linear Dependence and Independence, Basis and Dimension, Change of Basis; Normed Linear Spaces, Inner Products Spaces, Orthogonality, Orthogonal and Orthonormal Bases, Gram-Schmidt Orthogonalization Process, Orthogonal Complements, Orthogonal Projections. Applications to Difference Equations, Markov Chains.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                            |                              |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Linear Transformations and Matrix Decompositions</b>                                                                                                                                    | <b>(10L+3T=13 Sessions)</b>  |
| Linear Transformations, Algebra of Transformations, Singular and Nonsingular Linear Mappings, Isomorphisms, Matrix Representation of Linear Transformations, The Range and Null Space, Rank-Nullity Theorem.<br>Least Squares Approximation, Singular Value Decomposition: Singular Values, Computing Singular Value Decomposition, Data Compression Using Singular Value Decomposition and Introduction to Principal Component Analysis.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                            |                              |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Probability and Random Variables for machine learning</b>                                                                                                                               | <b>(15L+5T =20 Sessions)</b> |
| Introduction to Probability, Conditional Probability, Bayes' Theorem and Problems. Random Variables (discrete and continuous), Probability Mass/Density Functions, Mathematical Expectations, discrete probability distributions - Binomial distribution, Poisson distribution, Continuous uniform distribution - Exponential distribution, Normal distribution.<br>Machine learning: large language models<br>Targeted Applications & Tools that can be used: <ul style="list-style-type: none"> <li>Evaluation of definite and improper integrals for computing areas, volumes, surface areas, engineering design calculations, and scientific modeling using Beta and Gamma functions.</li> <li>Representation and analysis of high-dimensional vector spaces, feature extraction, orthogonal projections, signal processing, computer graphics, pattern recognition, and machine learning.</li> <li>Least-squares regression, image compression, recommendation systems, dimensionality reduction, Principal Component Analysis (PCA), data mining, and machine learning applications.</li> <li>Probabilistic modeling, Bayesian inference, uncertainty quantification, predictive analytics, classification algorithms, statistical learning, and foundations of large language models (LLMs).</li> </ul> Software: MATLAB, Mathematica, Maple, Python, GeoGebra, Octave, R, Scilab. |                                                                                                                                                                                            |                              |
| <b>Text Book</b> <ol style="list-style-type: none"> <li>E. Kreyszig, <i>Advanced Engineering Mathematics</i>, 10th ed. Hoboken, NJ, USA: John Wiley &amp; Sons, 2015.</li> <li>B. S. Grewal, <i>Higher Engineering Mathematics</i>, 45th ed. New Delhi, India: Khanna Publishers, 2017.sley Publishing Company.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                            |                              |
| <b>Assignment:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                            |                              |
| Assignments will involve theoretical problem-solving and computational implementation using suitable programming tools. The assignments may be undertaken individually or in groups, as decided by the instructor.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                            |                              |
| <b>References:</b> <ol style="list-style-type: none"> <li>G. Strang, <i>Introduction to Linear Algebra</i>, 6th ed. Wellesley, MA, USA: Wellesley-Cambridge Press, 2023.</li> <li>D. C. Lay, S. R. Lay, and J. J. McDonald, <i>Linear Algebra and Its Applications</i>, 6th ed. Harlow, U.K.: Pearson, 2021.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                            |                              |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                  |
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| 3. E. Kreyszig, <i>Advanced Engineering Mathematics</i> , 10th ed. Hoboken, NJ, USA: John Wiley & Sons, 2015.<br>4. B. S. Grewal, <i>Higher Engineering Mathematics</i> , 45th ed. New Delhi, India: Khanna Publishers, 2017.<br>5. C. D. Meyer, <i>Matrix Analysis and Applied Linear Algebra</i> , 2nd ed. Philadelphia, PA, USA: SIAM, 2023.<br><b>E-resources/ Web links:</b><br>1. <a href="https://open.umn.edu/opentextbooks/textbooks/24">https://open.umn.edu/opentextbooks/textbooks/24</a><br>2. <a href="https://open.umn.edu/opentextbooks/textbooks/introduction-to-probability">https://open.umn.edu/opentextbooks/textbooks/introduction-to-probability</a><br>3. <a href="https://open.umn.edu/opentextbooks/textbooks/linear-transformations-on-vector-spaces">https://open.umn.edu/opentextbooks/textbooks/linear-transformations-on-vector-spaces</a> |                                  |
| <b>Topics relevant to SKILL DEVELOPMENT:</b> The course focuses on the concepts of calculus and differential equation with reference to specific engineering problems. The course is of both conceptual and analytical type in nature through Problem solving. This is attained through the assessment component mentioned in course handout.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                  |
| <b>Catalogue prepared by</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Dr. Pavithra Sivaprakasam</b> |
| <b>Recommended by the Board of Studies on</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                  |
| <b>Date of Approval by the Academic Council</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                  |

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|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|---------|
| Course Code:<br>CIV1200 | Course Name: Foundations of Integrated Engineering<br>Type of Course: Theory Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | L- T-P- C | 2-0-0-2 |
| Version No.             | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |         |
| NCrF Level-             | 5.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |         |
| Course Pre-requisites   | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |         |
| Co-requisites           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |         |
| Anti-requisites         | CSEXxxx                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |         |
| Course Description      | This interdisciplinary course introduces first-year engineering students to foundational principles and practices across key engineering domains, emphasizing real-world problem-solving, sustainability, and ethical innovation. Students explore how civil, mechanical, electrical, and IT systems intersect with emerging technologies like IoT, AI, and geomatics to address global challenges. Through case studies, learners gain deeper understanding of smart infrastructure, prototyping mechanical/electronic systems, and securing IT solutions. Topics include bioinformatics for environmental monitoring, GIS-enabled urban planning, renewable energy integration, and cybersecurity fundamentals. The course cultivates a holistic understanding of engineering's role in sustainable development, safety, and ethical decision-making, preparing students to contribute meaningfully to multidisciplinary projects in a technology-driven world. |           |         |
| Course Objective        | The objective of the course is skill development of student by using Participative Learning techniques.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |         |

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| Course Outcomes                                                                                                                                                                                                                                                                                                                                         | On successful completion of the course the students shall be able to:                                                               |                   |                                   |            |
|                                                                                                                                                                                                                                                                                                                                                         | CO1: Recall key principles of Agile, DevOps, and bioinformatics used in interdisciplinary engineering contexts.                     |                   | L1- Remember                      |            |
|                                                                                                                                                                                                                                                                                                                                                         | CO2: Explain the role of GIS, LiDAR, and sustainable materials in designing smart infrastructure and disaster management systems.   |                   | L2- Understand                    |            |
|                                                                                                                                                                                                                                                                                                                                                         | CO3: Describe core components of mechanical systems and their real-world applications.                                              |                   | L3 - Apply                        |            |
|                                                                                                                                                                                                                                                                                                                                                         | CO4: Describe the functionality of IoT-enabled wearable devices, embedded systems, and renewable energy integration in smart grids. |                   | L4 - Analyze                      |            |
|                                                                                                                                                                                                                                                                                                                                                         | CO5: List foundational IT concepts such as cloud computing architectures, cybersecurity threats, and blockchain applications.       |                   | L5 - Evaluate                     |            |
| Course Content:                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                     |                   |                                   |            |
| Module 1                                                                                                                                                                                                                                                                                                                                                | Foundations of Engineering Practice                                                                                                 | Assignment        | Case studies                      | 6 Sessions |
| Real-world problem-solving using data logic and practical applications, Collaboration and Innovation through multi-domain project, Engineering Ethics & Environmental Impact<br>Emerging Fields: Automation, and Introduction to bioinformatics and its application<br>Sustainability & Safety: Circular economy principles, carbon footprint analysis. |                                                                                                                                     |                   |                                   |            |
| Module 2                                                                                                                                                                                                                                                                                                                                                | Civil Engineering & Geomatics                                                                                                       | Assignment        | Article Review                    | 6 Sessions |
| Smart Infrastructure & Geomatics: GIS mapping, LiDAR, drone surveys for urban planning, Geospatial data analysis for disaster management.<br>Sustainable Construction: 3D-printed structures, self-healing concrete, Digital twins for infrastructure monitoring.<br>Green Innovations: Net-zero energy buildings, rainwater harvesting systems.        |                                                                                                                                     |                   |                                   |            |
| Module 3                                                                                                                                                                                                                                                                                                                                                | Mechanical Engineering in Action                                                                                                    | Assignment & Quiz | Data Collection                   | 6 Sessions |
| Advanced Manufacturing: Collaborative robots (cobots), additive manufacturing and 3D printing, Reverse engineering and prototyping.<br>Energy Systems: Solar/wind energy harvesting, piezoelectric applications.<br>Biomechanics: Prosthetics design, ergonomic product lifecycle.                                                                      |                                                                                                                                     |                   |                                   |            |
| Module 4                                                                                                                                                                                                                                                                                                                                                | Electrical & Electronics Engineering                                                                                                | Assignment & Quiz | Data Collection and visualization | 6 Sessions |
| Smart Devices & Systems: Embedded systems, Wearable technology, Edge computing and hardware platforms<br>Energy Innovations: EV charging infrastructure, wireless power transfer, Smart grid integration with renewables.                                                                                                                               |                                                                                                                                     |                   |                                   |            |
| Module 5                                                                                                                                                                                                                                                                                                                                                | Fundamentals of IT                                                                                                                  | Assignment & Quiz | Case studies                      | 6 Sessions |
| Core IT Topics: Networking basics, Cloud computing<br>Cybersecurity & Data: Encryption, phishing prevention, zero-trust models, Database management.<br>Emerging Tech: Blockchain for supply chains, AI/ML basics, IoT integration with cloud platforms                                                                                                 |                                                                                                                                     |                   |                                   |            |
| Targeted Application & Tools that can be used:<br>Application Areas include Interdisciplinary problem-solving, Smart city planning, disaster management, Robotics prototyping, renewable energy systems, Wearable health tech, smart grids, Secure cloud systems.<br>Tools: 3D Printers, Autocad, Tinkercad, ArcGIS / QGIS, Arduino/Raspberry Pi        |                                                                                                                                     |                   |                                   |            |
| Text Book:                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                     |                   |                                   |            |

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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ol style="list-style-type: none"> <li>1. William Oakes &amp; Les Leone, "Engineering Your Future: An Introduction to Engineering", Oxford University Press, 9th Edition, 2021</li> <li>2. Barry F. Kavanagh, "Introduction to Geomatics", Pearson, 5th Edition, 2021</li> <li>3. Ian Gibson, David Rosen, &amp; Brent Stucker, "Additive Manufacturing Technologies", Springer, 3rd Edition, 2021</li> <li>4. Sudip Misra, "The Internet of Things: Enabling Technologies, Protocols, and Use Cases", Wiley, 2nd Edition, 2022</li> <li>5. James Kurose &amp; Keith Ross, "Computer Networking: A Top-Down Approach", Pearson, 8th Edition, 2020</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <p>References</p> <ol style="list-style-type: none"> <li>1. Supratim Choudhuri, "Bioinformatics for Beginners: Genes, Genomes, and Molecular Evolution", Academic Press, 1st Edition, 2023,</li> <li>2. Robert McGinn, "The Ethical Engineer: Contemporary Concepts and Cases", Princeton University Press, 1st Edition, 2020</li> <li>3. Charles J. Kibert, "Sustainable Construction: Green Building Design and Delivery", Wiley, 5th Edition, 2022</li> <li>4. Anthony M. Townsend, "Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia", W.W. Norton &amp; Company, 1st Edition, 2020</li> <li>5. David Buchla, "Renewable Energy Systems: A Smart Energy Systems Approach", Pearson, 2nd Edition, 2023</li> <li>6. Charles Platt, "Make: Electronics: Learning Through Discovery", Make Community, 3rd Edition, 2021</li> <li>7. Charles J. Brooks, Christopher Grow, &amp; Philip Craig, "Cybersecurity Essentials", Wiley, 2nd Edition, 2021</li> </ol>                                                                                                                                                                                                                                                                                                  |
| <p>Web-resources:</p> <ol style="list-style-type: none"> <li>1. Post-parametric Automation in Design and Construction<br/><a href="https://search.ebscohost.com/login.aspx?direct=true&amp;db=nlebk&amp;AN=1155197&amp;site=ehost-live">https://search.ebscohost.com/login.aspx?direct=true&amp;db=nlebk&amp;AN=1155197&amp;site=ehost-live</a></li> <li>2. Smart Cities : Introducing Digital Innovation to Cities<br/><a href="https://search.ebscohost.com/login.aspx?direct=true&amp;db=nlebk&amp;AN=1993146&amp;site=ehost-live">https://search.ebscohost.com/login.aspx?direct=true&amp;db=nlebk&amp;AN=1993146&amp;site=ehost-live</a></li> <li>3. Innovation Energy: Trends and Perspectives or Challenges of Energy Innovation<br/><a href="https://search.ebscohost.com/login.aspx?direct=true&amp;db=nlebk&amp;AN=2323766&amp;site=ehost-live">https://search.ebscohost.com/login.aspx?direct=true&amp;db=nlebk&amp;AN=2323766&amp;site=ehost-live</a></li> <li>4. Additive Manufacturing: Opportunities, Challenges, Implications<br/><a href="https://search.ebscohost.com/login.aspx?direct=true&amp;db=nlebk&amp;AN=1134464&amp;site=ehost-live">https://search.ebscohost.com/login.aspx?direct=true&amp;db=nlebk&amp;AN=1134464&amp;site=ehost-live</a></li> </ol> |

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| Course Code:<br>CHE2501 | Course Name: Chemistry of Smart Materials<br>Type of Course: Theory Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | L- T-P- C | 3-0-0-3 |
| Version No.             | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |         |
| NCrF Level-             | 5.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |         |
| Course Pre-requisites   | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |         |
| Co-requisites           | CHE2501                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |         |
| Anti-requisites         | CSEXXXX                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |         |
| Course Description      | The objective of the course is to introduce the students to concepts and applications of chemistry of smart materials. The course also aims to enhance the knowledge of smart materials associated with memory system, display devices, , sensors, energy devices and environment. It will also cultivate an ability to identify chemistry in each of smart engineered materials and interpret solutions for the challenges connected to memory, display, energy, smart, green and sustainable technologies. It targets to strengthen the fundamental concepts behind chemistry of smart materials and then builds an interface with their industrial applications. |           |         |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>This course is designed to cater to Environment and Sustainability</b>                                                                 |                        |                              |                    |
| Course Objective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | The objective of the course is ‘SKILL DEVELOPMENT’ of the student by using Participative learning techniques.                             |                        |                              |                    |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>On successful completion of the course the students shall be able to:</b>                                                              |                        |                              |                    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>C01:</b> Relate the knowledge of chemistry to computational approaches to identify materials functionalities and properties            | <b>L1</b> – Remember   |                              |                    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>C02:</b> Recognize and interpret solutions for the challenges connected to memory, display, smart, green and sustainable technologies. | <b>L2</b> – Understand |                              |                    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>C03:</b> Explain the quality parameters of engineering materials associated with environment and sensors.                              | <b>L3</b> – Apply      |                              |                    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>C04:</b> Interpret the knowledge of sustainable chemistry for E-waste management.                                                      | <b>L4</b> – Analyze    |                              |                    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>C05:</b> Analyse the importance of various electrochemical sources in energy systems.                                                  | <b>L5</b> – Evaluate   |                              |                    |
| Course Content:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                           |                        |                              |                    |
| <b>Module 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Computational Chemistry                                                                                                                   | Assignment             | Data Collection and analysis | <b>09 Sessions</b> |
| <b>Topics:</b> Fundamental particles of atom – their mass, charge and location – atomic number and mass number, Stabilizing interactions: Bonded and non-bonded interactions. Chemistry of weak interactions – van der Waals force and hydrogen bonding, Density functional theory. 3D co-ordinate generation for small molecules, geometry optimization by Molview. Chemical Databases: Chemoinformatics, MSDS<br><b>Self- learning topics:</b> Scope, cost and efficiency of computational modeling.                                                                                                                               |                                                                                                                                           |                        |                              |                    |
| <b>Module 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Materials for Memory and Display Systems                                                                                                  | Assignment             | Data Collection and analysis | <b>09 Sessions</b> |
| <b>Topics: Memory Systems :</b> Introduction, classification of electronic memory devices- Transistor, capacitor, charge -transfer and Resistor, types of materials - organic, polymeric and hybrid materials, and applications, manufacturing of semiconductor chips.<br><b>Display Systems:</b> photo and electroactive materials , materials for display -Principle, Properties and applications: Liquid crystals for LCD-Liquid crystals display, Basics of LED: OLED-organic light emitting diode and light emitting electrochemical cells.<br><b>Self- learning topics:</b> Green computing: Biocomposite based memory devices |                                                                                                                                           |                        |                              |                    |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Nanomaterials based Smart Sensors and Devices                                                                                             | Assignment             | Data Collection and analysis | <b>09 Sessions</b> |
| <b>Topics: Nanomaterials-</b> Introduction, classification based on dimensionality, quantum confinement. Size dependent properties, Synthesis, Properties of CNT and Graphene and their application as <b>Materials for data analysis and packaging</b> -RFID and IONT.<br><b>Sensors:</b> Introduction, types, Principle and applications- electrochemical sensor: nanomaterials for sensing applications - Glucose, VOC sensing.<br><b>Self-learning topics:</b> Fullerene, biomolecules in sensing, Strain sensors                                                                                                                |                                                                                                                                           |                        |                              |                    |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Sustainable Materials and Development                                                                                                     | Quiz/Seminar           | Data Collection and analysis | <b>09 Sessions</b> |
| <b>Topics: E waste:</b> Introduction, E waste Hazards, E- waste management, Recovery of precious metal- Cu                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                           |                        |                              |                    |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                |              |                              |                    |
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| by Hydrometallurgy.<br><b>Green Chemistry:</b> Fundamentals and 12 principles with examples, Carbon footprint and sequestration<br><b>Sustainable Chemistry:</b> -Introduction to Biomaterials- PLA, polymers in bio-compatible and bio-degradable materials - Poly(3-hydroxybutyrate-co-3-hydroxyvalerate) PHBV, synthesis and applications in drug delivery.<br><b>Self-learning topics:</b> circular economy- case studies.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |                              |                    |
| <b>Module 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Energy Science | Quiz/Seminar | Data Collection and analysis | <b>09 Sessions</b> |
| <b>Topics: Battery technology:</b> Fundamentals of electrochemistry, Introduction to electrochemical storage devices: battery (Lithium-ion battery- $\text{LiMnO}_2$ , $\text{LiCoO}_2$ , metal air batteries- $\text{LiO}_2$ ) and supercapacitors- Introduction, Principle, Types - EDLC, pseudo and asymmetric capacitor.<br><b>Photovoltaics:</b> Solar cells - Construction and working principle; types- Inorganic, Organic and quantum dot sensitized (QDSSC's).<br><b>Self-learning topics:</b> Battery technology for e-mobility, Green hydrogen                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                |              |                              |                    |
| <b>Targeted Application &amp; Tools that can be used:</b><br>Application areas are Data storage and analysis, logistics, Biomedicine, Energy, Environment and sustainability<br><b>Tools:</b> Molview, chemdraw, excel etc                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                |              |                              |                    |
| <b>Project work/Assignment:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                |              |                              |                    |
| <b>Assessment Type</b> <ul style="list-style-type: none"> <li>• Midterm exam</li> <li>• Assignment (review of digital/ e-resource from PU link given in references section - mandatory to submit screenshot accessing the digital resource.)</li> <li>• Quiz/Student Seminar</li> <li>• End Term Exam</li> <li>• Self-learning</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                |              |                              |                    |
| <b>Text Book</b> <ol style="list-style-type: none"> <li>1. Wiley, "Engineering Chemistry", Wiley.</li> <li>2. G.A. Ozin and A.C. Arsenault, Nanochemistry: A chemical approach to nanomaterials, Royal Society of Chemistry, 2009</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                |              |                              |                    |
| <b>Reference Books</b> <ol style="list-style-type: none"> <li>1. Functional and smart materials, Chander Prakash, Sunpreet Singh, J. Paulo Davim, 2020, CRC Press,</li> <li>2. ISBN: 978-036-727-510-5.</li> <li>3. E-waste recycling and management: present scenarios and environmental issues, Khan, Anish, and</li> <li>4. Abdullah M. Asiri. 2019, Springer, Vol. 33. ISBN: 978-3-030-14186-8.</li> <li>5. Essentials of computational chemistry: theories and models, Christopher J Cramer, 2013, John Wiley &amp;</li> <li>6. Sons. ISBN: 978-0-470-09182-1.</li> <li>7. Energy storage and conversion devices: Supercapacitors, batteries and hydroelectric cells, Anurag Gaur,</li> <li>8. L. Sharma, Anil Arya. 2021, CRC press, 1st edition, ISBN: 978-1-003-14176-1.</li> <li>9. Fundamentals of analytical chemistry: An introduction, Douglas A. Skoog et al., 2004 Thomson Asia pte</li> <li>10. Ltd., 8th, ISBN: 978-0-495-55828-6</li> <li>11. Functional and smart materials, Chander Prakash, Sunpreet Singh, J. Paulo Davim, 2020, CRC Press,</li> <li>12. ISBN: 978-036-727-510-5.</li> <li>13. Electrical and electronic devices, circuits and materials: Technological challenges and solutions. Tripathi,</li> <li>14. L., Alvi, P. A., &amp; Subramaniam, U, 2021, John Wiley &amp; Sons, ISBN: 978-0367564261.</li> <li>15. F. Jensen, Introduction to Computational Chemistry, 3rd edition, Wiley, 2017.</li> </ol> |                |              |                              |                    |

**E resources**

1. <https://presiuniv.knimbus.com/user#/searchresult?searchId=computational%20chemistry& t=1738054970142>
2. <https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE BASED&unique id=EBSCO95 30102024 48504>
3. <https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE BASED&unique id=EBSCO95 30102024 147967>
4. <https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE BASED&unique id=EBSCO95 30102024 130301>
5. <https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE BASED&unique id=EBSCO95 30102024 87297>
6. <https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE BASED&unique id=EBSCO95 30102024 67006>
7. <https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE BASED&unique id=EBSCO95 30102024 137261>
8. <https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE BASED&unique id=EBSCO95 30102024 86712>

**Skill Sets**

All topics in theory component are relevant to Environment and Sustainability.

|                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                |
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| <b>Course Code: CSS2200</b>  | <b>Course Title: Program Solving Using C</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>L- T-P-C</b> | <b>2-0-0-2</b> |
| <b>Type of Course:</b>       | <b>Theory Course</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                 |                |
| <b>Version No.</b>           | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |                |
| <b>Course Pre-requisites</b> | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |                |
| <b>Anti-requisites</b>       | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |                |
| <b>Course Description</b>    | The course is designed to provide a strong foundation in the C programming language and problem-solving techniques. It enables students to develop logical thinking and programming skills required to design and implement applications using C. By understanding fundamental programming concepts such as algorithms, control structures, arrays, functions, pointers, and data handling, students will be prepared to learn and adapt to other programming languages and advanced computing technologies in the future.                                                                                                                                                                                                                                                                                                                             |                 |                |
| <b>Course Objective</b>      | The objective of the course is to familiarize the learners with the concepts of Problem Solving Using C and attain Employability through Problem Solving Methodologies.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                |
| <b>Course Outcomes</b>       | <p><b>On successful completion of this course the students shall be able to:</b></p> <p><b>C01:</b> Explain problem-solving techniques using algorithms,[Level 2 – Understand] pseudo code, and flowcharts for developing programs</p> <p><b>C02:</b> Apply fundamental C programming constructs such as data[Level 3 – Apply] types, operators, decision-making, and looping statements to develop simple programs.</p> <p><b>C03:</b> Develop programs using arrays and strings to solve[Level 3 – Apply] computational problems effectively</p> <p><b>C04:</b> Implement modular and reusable programs using functions,[Level 3 – Apply] recursion, and pointers.</p> <p><b>C05:</b> Design applications using structures, unions, file handling[Level 3 – Apply] concepts, and demonstrate the role of C programming in emerging technologies.</p> |                 |                |
| <b>Course Content:</b>       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                |

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| <b>Module 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Introduction to C Language</b>                                       | <b>Assignment<br/>(Algorithms,<br/>Flowcharts, and Basic<br/>C Programs)</b>                           | <b>6 Sessions</b> |
| <b>Topics:</b><br>Introduction to Programming – Algorithms – Pseudo Code - Flow Chart – Compilation – Execution – Preprocessor Directives (#define, #include, #undef) - Overview of C – Constants, Variables and Data types – Operators and Expressions – Managing Input and Output Operations – Decision Making and Branching - Decision Making and Looping.                                                                                                                            |                                                                         |                                                                                                        |                   |
| <b>Module 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Introduction to Arrays and Strings</b>                               | <b>Programming<br/>Assignment (Arrays,<br/>Sorting, Searching,<br/>and String Handling in<br/>C)</b>   | <b>6 Sessions</b> |
| <b>Topics:</b><br><b>Arrays:</b> Introduction – One Dimensional Array – Initialization of One Dimensional Arrays – Example Programs – Sorting (Bubble Sort, Selection Sort) – Searching (Linear Search) - Two Dimensional Arrays – Initialization of Two Dimensional Arrays. Example Programs – Matrix operations. <b>Strings:</b> Introduction – Declaring and Initializing String<br>Variables – Reading Strings from Terminal – Writing String to Screen – String Handling Functions. |                                                                         |                                                                                                        |                   |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Functions and Pointers</b>                                           | <b>Programming<br/>Assignment<br/>(Functions, Recursion,<br/>and Pointer<br/>Implementation in C)</b>  | <b>6 Sessions</b> |
| <b>Topics:</b><br><b>Functions:</b> Introduction – Need for User-defined functions – Elements of User-Defined Functions: declaration, definition and function call–Categories of Functions – Recursion. <b>Pointers:</b> Introduction – Declaring Pointer Variables – Initialization of Variables – Pointer Operators – Pointer Arithmetic – Arrays and Pointers – Parameter<br>Passing: Pass by Value, Pass by Reference.                                                               |                                                                         |                                                                                                        |                   |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Structures and Union and File Handling</b>                           | <b>Assignment<br/>(Structures, Unions,<br/>and File Operations in<br/>C)</b>                           | <b>6 Sessions</b> |
| <b>Topics:</b><br><b>Structures:</b> Introduction – Defining a Structure – Declaring Structure Variable – Accessing Structure Members – <b>Union:</b> Introduction – Defining and Declaring Union – Difference Between Union and Structure.- <b>File handling:</b> Defining and Opening a File – Closing a File – Input / Output Operations on File.                                                                                                                                     |                                                                         |                                                                                                        |                   |
| <b>Module 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Application of C Programming in Emerging<br/>CSE Specializations</b> | <b>Mini Project (C<br/>Programming<br/>Applications in Cyber<br/>Security, Blockchain,<br/>and AI)</b> | <b>6 Sessions</b> |
| <b>Topics:</b><br>Applications of C Programming in modern technologies – Cyber Security: Simple password checking programs and basic security concepts – Blockchain: Secure data storage and transaction concepts – Artificial Intelligence and Machine Learning: Basic data processing programs.                                                                                                                                                                                        |                                                                         |                                                                                                        |                   |
| <b>Text Book(s):</b><br>1. E. Balaguruswamy, “Programming in ANSI C”, 8th Edition, 2019, McGraw Hill Education, ISBN: 978-93-5316- 513-0.                                                                                                                                                                                                                                                                                                                                                |                                                                         |                                                                                                        |                   |

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| <b>Reference Book(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |  |  |  |  |  |
| <ol style="list-style-type: none"> <li>1. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.</li> <li>2. Reema Thareja, "Programming in C", Oxford University Press, Second Edition, 2016.</li> <li>3. Kernighan, B.W and Ritchie, D.M, "The C Programming language", Second Edition, Pearson Education, 2015</li> <li>4. Schildt Herbert, "C: The Complete Reference", Tata McGraw Hill Education, 4th Edition, 2014.</li> <li>5. Stephen G. Kochan, "Programming in C", Addison-Wesley Professional, 4th Edition, 2014.</li> </ol> |  |  |  |  |  |  |
| <b>Web Links and Video Lectures:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |  |  |  |  |  |
| <ol style="list-style-type: none"> <li>1. <a href="#">NPTEL – Programming in C</a></li> <li>2. <a href="#">NPTEL – Problem Solving Through Programming in C</a></li> <li>3. <a href="#">GeeksforGeeks – C Programming Language</a></li> </ol>                                                                                                                                                                                                                                                                                                        |  |  |  |  |  |  |

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| <b>Course Code:</b><br>ENG2030 | <b>Course Title:</b> Communication in Practice<br><b>Type of Course:</b> Integrated                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>L-T-P-C</b> | 1 | 0 | 2 | 2 |
| <b>Version No.</b>             | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                |   |   |   |   |
| <b>Course Pre-requisites</b>   | ENG XXXX – Fundamentals of Communication (Semester I)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                |   |   |   |   |
| <b>Anti-requisites</b>         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                |   |   |   |   |
| <b>Course Description</b>      | <p><i>Communication in Practice</i> is the second-semester course in sequence designed for first-year undergraduate students in engineering and computer science programmes. This course puts those foundations under professional pressure. The question is no longer <i>what</i> communication is, but <i>how</i> to deploy it when it counts: in a job interview, a pitch to a client, a negotiation with a colleague, a professional report directed at a real reader, or a leadership communication challenge that affects a team. The course is organised around four modules, each of which explicitly upgrades the work done in semester one. Assessment is 100% Continuous Assessment. There is no end-semester examination. The centrepiece is a capstone Professional Communication Portfolio that the student could realistically share with an employer.</p> |                |   |   |   |   |
| <b>Course Objective</b>        | <p>The course aims to articulate the foundational tenets of professional communicative identity, discourse ethics, and analytical text evaluation and apply them to high-stakes institutional scenarios and complex professional ecosystems. It also focuses on cultivating advanced oral communication strategies and persuasive vocal mechanics, including structured rhetorical delivery and spontaneous adaptive responses, for collaborative, hierarchical, and leadership contexts. Furthermore, it aims to refine technical authorship capabilities and artificial intelligence-mediated workflows to produce precise, highly structured, and audience-centric professional artifacts across formal engineering, computational, and cross-functional corporate domains.</p>                                                                                        |                |   |   |   |   |
| <b>Course Outcomes</b>         | <p><b>On successful completion of this course the students shall be able to:</b></p> <ol style="list-style-type: none"> <li>6. <b>Explain</b> the principles governing professional communication identity, communicator ethics, and context-sensitive self-presentation across workplace, hierarchical, and digital contexts.</li> <li>7. <b>Demonstrate</b> advanced vocal, rhetorical, and adaptive strategies across high-stakes spoken communication genres, including interviews, pitches,</li> </ol>                                                                                                                                                                                                                                                                                                                                                               |                |   |   |   |   |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | negotiations, and leadership scenarios.                                                                                                                                                                                                                                         |     |                                                     |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 8. <b>Demonstrate</b> advanced vocal, rhetorical, and adaptive strategies across high-stakes spoken communication genres, including interviews, pitches, negotiations, and leadership scenarios.                                                                                |     |                                                     |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 9. <b>Execute</b> the production of professional-grade written artifacts across high-demand genres—including formal reports, business proposals, data communications, and advocacy briefs—meeting real-world standards of clarity, structure, and audience appropriateness.     |     |                                                     |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 10. <b>Implement</b> AI-assisted communication workflows in professional contexts, including systematic prompt design for high-stakes outputs, validation protocols for synthetic materials, and the application of ethical frameworks at individual and organizational levels. |     |                                                     |             |
| Course Content: Communication in Practice                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                 |     |                                                     |             |
| Module 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Words that Work: Vocabulary, Register, and Precision                                                                                                                                                                                                                            | CA1 | Register Switching Activity                         | 09 Sessions |
| <p>The topics will be explored through vocabulary games, role-play activities, communication challenges, case-based tasks, and workplace simulations:</p> <ul style="list-style-type: none"><li>• Why Words Matter in Professional and Technical Communication</li><li>• Choosing the Right Words for Different Situations</li><li>• Understanding Meaning: Positive, Negative, and Neutral Word Choices</li><li>• Commonly Confused Words and Miscommunication in Professional Contexts</li><li>• Using Clear, Precise, and Concise Language</li><li>• Explaining Technical Terms to Non-Technical Audiences</li><li>• Building and Using Personal/Professional Vocabulary</li></ul>                                               |                                                                                                                                                                                                                                                                                 |     |                                                     |             |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Listening, Processing, and Structured Response Writing                                                                                                                                                                                                                          | CA2 | Rapid Listening and Response                        | 12 Sessions |
| <p>The topics will be explored through podcasts, interviews, workplace recordings, collaborative listening tasks, discussions, and real-time writing activities:</p> <ul style="list-style-type: none"><li>• Identifying Key Information from Spoken Inputs</li><li>• Organizing Information from Discussions and Conversations</li><li>• Converting Spoken Communication into Clear and Structured Written Responses</li><li>• Writing Summaries from Audio and Discussion Inputs</li><li>• Writing Follow-Up Responses Based on Spoken Communication</li><li>• Writing Action Notes, Instructions, and Task Updates from Listening Inputs</li><li>• Converting Meetings and Discussions into Structured Written Outputs</li></ul> |                                                                                                                                                                                                                                                                                 |     |                                                     |             |
| Module 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | High-Stakes Spoken Communication                                                                                                                                                                                                                                                | CA  | Mock Professional Interview, Pitching an Idea Pitch | 12 Sessions |
| <ul style="list-style-type: none"><li>• Speaking as a professional: identity, presence, and the first impression</li><li>• Vocal authority, physical presence, and communication across hierarchies</li><li>• Interview communication: structure, composure, and the STAR framework</li><li>• Pitching ideas: the 3-minute and 10-minute pitch architecture</li><li>• Negotiation and principled disagreement</li><li>• Communicating in leadership positions: chairing, facilitating, and giving direction</li></ul>                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                 |     |                                                     |             |

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| <ul style="list-style-type: none"> <li>Managing communication under pressure: hostile questions, silence, and contradiction</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                               |           |                                    |                    |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Adaptive Communication</b> | <b>CA</b> | <b>Communication Strategy Plan</b> | <b>12 Sessions</b> |
| <p>The topics will be explored through leadership simulations, AI-assisted scenario practice, ethical debate exercises, case analysis, peer feedback sessions, and reflective portfolio activities:</p> <ul style="list-style-type: none"> <li>Communication Strategy: Audiences, Channels, Timing, and Feedback Loops</li> <li>What Emotional Intelligence Actually Does in High-Stakes Conversations</li> <li>Reading the Room: Adapting Style Across Personalities, Contexts, and Power Gaps</li> <li>Giving and Receiving Developmental Feedback as a Professional Practice</li> <li>Navigating Difficult Conversations: Disagreement, Criticism, and Bad News</li> <li>Repairing Communication Breakdowns: Apology, Accountability, and Recovery</li> <li>AI as a Strategic Communication Tool: Capabilities, Limits, and What Professionals Must Decide</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                               |           |                                    |                    |
| <p><b>Targeted Application &amp; Tools that can be used:</b> Otter.ai, Microsoft Word/PowerPoint/Teams/Clipchamp/Whiteboard/OneNote/Forms/Copilot, Miro, Padlet, Canva, Mentimeter, AllSides Media Bias Ratings, Ad Fontes Media Bias Chart, Snopes/factcheck.rog, Zotero, NotebookLM, Canva, Adobe Express, CapCut, OBS Studio, Claude, ChatGPT, Gemini, DeepSeek, Google Docs</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                               |           |                                    |                    |
| <p><b>Project Work / Assignment:</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                               |           |                                    |                    |
| <p><b>1. Register Switching Activity (Individual):</b> Students receive a single professional scenario and must communicate the same core message to three different audiences — a peer, a manager, and a non-specialist outsider — switching register, vocabulary, and tone appropriately for each. Delivered live in class. Graded on accuracy of register shift, vocabulary choices, and adaptability under in-the-moment feedback from the assessor.</p> <p><b>2. Word in the Wild Log (Individual):</b> Over four weeks, students maintain a running log of 25 words or phrases encountered in professional contexts — podcasts, workplace conversations, news, interviews — that they did not fully understand or could not have used confidently themselves. For each entry, students record the source, the meaning in context, an alternative they might have used, and one original sentence demonstrating precise use. Submitted as a structured document at the end of Module 1. Graded on range, contextual accuracy, and quality of reflection.</p> <p><b>3. Rapid Listening and Response (Individual):</b> Students listen to an unedited workplace audio recording — a meeting excerpt, a briefing, or a professional conversation — played once, without transcripts. Under timed conditions, they produce a structured written response that captures key information, identifies the communication purpose, and drafts an appropriate follow-up action note. Graded on accuracy, organisation, and quality of written response.</p> <p><b>4. Mock Professional Interview (Individual):</b> Each student undergoes a 10-minute mock professional interview conducted by faculty or a peer panel. No prepared scripts permitted. Graded on composure, structure, vocal authority, and use of the STAR framework. Written self-evaluation of 200 words submitted within 48 hours.</p> <p><b>5. Idea Pitch (Individual):</b> Students deliver a 3-minute pitch of a solution to a real or simulated professional problem, to a panel that includes at least one hostile or sceptical questioner. Immediately after the pitch, the panel asks two minutes of unscripted questions. Graded on clarity of argument, persuasive structure, handling of pressure, and vocal presence.</p> <p><b>6. Difficult Conversation Simulation (Pair):</b> Pairs of students are assigned roles in a scripted conflict scenario — a performance issue, a missed deadline, a broken professional agreement. Each student must</p> |                               |           |                                    |                    |

navigate the conversation toward a constructive resolution without a script. Immediately after, both students complete a structured individual debrief identifying what communication choices they made, what they would change, and what they observed in their partner. Graded individually on communication behaviour during the simulation and quality of the debrief.

**7. Communication Strategy Plan — Presentation and Portfolio Submission (Group):** Students select a real or realistic professional scenario — a team conflict, a stakeholder disagreement, a leadership announcement, or a crisis communication moment. They develop a communication strategy plan that maps the audience, chooses appropriate channels and timing, anticipates likely responses, and identifies where AI tools could assist and where they must not. The plan is delivered as a 5-minute structured presentation to a simulated panel, followed by two minutes of unscripted Q&A. The portfolio submission includes the written plan, a one-page reflection on their communication growth across all four modules, and one piece of evidence from each module that demonstrates that growth. Graded on strategic thinking, clarity of presentation, quality of reflection, and coherence of the portfolio as a whole.

#### Text Book(s):

T1. Treasure, J. (2017). *How to be Heard: Secrets for Powerful Speaking and Listening*. Mango Publishing.  
T2. Beebe, S. A., Beebe, S. J., & Ivy, D. K. (2019). *Communication: Principles for a Lifetime* (7th ed.). Pearson.

#### Reference Book(s):

R1. Goleman, D. (1995). *Emotional Intelligence: Why It Can Matter More Than IQ*. Bantam Books.  
R2. Patterson, K., Grenny, J., McMillan, R., & Switzler, A. (2011). *Crucial Conversations: Tools for Talking When Stakes Are High* (2nd ed.). McGraw-Hill.  
R3. Cuddy, A. (2015). *Presence: Bringing Your Boldest Self to Your Biggest Challenges*. Little, Brown and Company.  
R4. Fisher, R., Ury, W., & Patton, B. (2011). *Getting to Yes: Negotiating Agreement Without Giving In* (3rd ed.). Penguin Books.  
R5. Stone, D., Patton, B., & Heen, S. (2010). *Difficult Conversations: How to Discuss What Matters Most* (2nd ed.). Penguin Books.

#### Web Sources:

- [ted.com/topics/communication](https://www.ted.com/topics/communication)
- [ted.com/topics/leadership](https://www.ted.com/topics/leadership)
- [hbr.org](https://hbr.org) (Harvard Business Review — communication and leadership articles)
- [psychologytoday.com/us/basics/emotional-intelligence](https://psychologytoday.com/us/basics/emotional-intelligence)
- [learnprompting.org](https://learnprompting.org)
- [unesco.org/en/artificial-intelligence/ethics](https://unesco.org/en/artificial-intelligence/ethics)
- [yoodli.ai](https://yoodli.ai) (AI speech coaching)
- [themuse.com](https://themuse.com) (professional communication and career resources)
- [mindtools.com](https://mindtools.com) (communication skills and workplace tools)

**Topics relevant to "SKILL DEVELOPMENT":** Vocabulary building and register awareness; precise and concise language use; explaining technical terms to non-specialist audiences; active listening and information processing; converting spoken inputs into structured written responses; writing action notes and follow-up communications; professional presence and vocal authority; interview communication and

the STAR framework; idea pitching and persuasive speaking; negotiation and principled disagreement; chairing and facilitating discussions; managing communication under pressure; communication strategy and audience mapping; emotional intelligence in professional contexts; adapting communication style across personalities and power gaps; giving and receiving developmental feedback; navigating difficult conversations; repairing communication breakdowns; AI as a strategic communication tool; ethics of AI in professional communication.

|                                                 |                                               |
|-------------------------------------------------|-----------------------------------------------|
| <b>Catalogue prepared by</b>                    | Dr Ajith K and Dr Shahanas Punnilath Shanavas |
| <b>Recommended by the Board of Studies on</b>   |                                               |
| <b>Date of Approval by the Academic Council</b> |                                               |

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| Course Code:<br>EEE1200                                                                                                                                                                                                                                                                                                                     | Course Title: Basics of Electrical and Electronics Engineering.<br>Type of Course: Theory - ESC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                  | L-T-P-C                | 3           | 0 | 0 | 3 |
| Version No.                                                                                                                                                                                                                                                                                                                                 | 2.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                  |                        |             |   |   |   |
| Course Pre-requisites                                                                                                                                                                                                                                                                                                                       | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                  |                        |             |   |   |   |
| Anti-requisites                                                                                                                                                                                                                                                                                                                             | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                  |                        |             |   |   |   |
| Course Description                                                                                                                                                                                                                                                                                                                          | This is a fundamental Course which is designed to know the use of basics of electrical and electronics engineering principles occurs in various fields of Engineering. The course emphasises on the characteristics and applications of electrical and electronic devices. The course also emphasizes on the working, analysis and design of electrical circuits using both active & passive components. Additionally, this course creates a foundation for the future courses such as Electrical machines, power system, power electronics Linear Integrated Circuits, Analog Communication and Digital Communication etc. |                  |                        |             |   |   |   |
| Course Objective                                                                                                                                                                                                                                                                                                                            | The objective of the course is to familiarize the learners with the concepts of Basics of Electrical and Electronics Engineering and attain Skill Development through Participative Learning techniques.                                                                                                                                                                                                                                                                                                                                                                                                                    |                  |                        |             |   |   |   |
| Course Outcomes                                                                                                                                                                                                                                                                                                                             | On successful completion of this course the students shall be able to:<br>Apply basic laws of Electrical Engineering to compute voltage, currents and other parameters in the circuits.<br>Discuss various fundamental parameters appearing in the characteristics of semiconductor devices and their applications.<br>Summarize the operations of different biasing configurations of BJTs and amplifiers.<br>Discuss the performance characteristics and applications of various electrical Machines.                                                                                                                     |                  |                        |             |   |   |   |
| Course Content:                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                  |                        |             |   |   |   |
| Module 1                                                                                                                                                                                                                                                                                                                                    | Introduction to Electrical Circuits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Assignment/ Quiz | Numerical solving Task | 10 Sessions |   |   |   |
| DC Circuits: Concept of Circuit and Network, Types of elements, Network Reduction Techniques- Series and parallel connections of resistive networks, Star-to-Delta Transformations, Mesh Analysis, Nodal Analysis, Numerical examples.<br>AC Circuits: Fundamentals of single phase circuits - Series RL, RC and R-L-C Circuits, Concept of |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                  |                        |             |   |   |   |

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| active power, reactive power and Power factor, Numerical examples.<br>Introduction to three phase system and relation between line and phase values in Star & Delta connection, Numerical examples.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                      |                  |                             |             |
| <b>Module 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Semiconductor and Diode applications | Assignment/ Quiz | Memory Recall based Quizzes | 10 Sessions |
| Mass Action Law, Charge densities in a semiconductor, Types of SC, Junction diodes -Ideal and practical behaviour, Modelling the Diode Forward Characteristic, and Diode applications like rectifiers, Zener diode, characteristics and its applications like voltage regulator.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                      |                  |                             |             |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Transistors and its Applications     | Assignment/ Quiz | Memory Recall-based Quizzes | 10 Sessions |
| Transistor characteristics, Current components, BJT Configurations (CB, CC, CE configurations) and their current gains. Operating point, Biasing, Fixed Bias, and load line analysis. Single Stage amplifier. JFET (Construction, principal of Operation and Volt –Ampere characteristics). Pinch- off voltage, Comparison of BJT and FET. MOSFET (Construction, principal of Operation and symbol), MOSFET characteristics in Enhancement and Depletion modes.                                                                                                                                                                                                                                                                                                                     |                                      |                  |                             |             |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Fundamentals of Electrical Machines  | Assignment/ Quiz | Numerical solving Task      | 10 Sessions |
| Electrical Machines: Single phase transformers: principle of operation and EMF equation, Numerical examples. DC Motor: principle of operation, Back EMF, torque equation, Numerical examples. AC Motor: Principle operation of Induction Motors and its Applications.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                      |                  |                             |             |
| <b>Self-Learning Topics:</b> <ul style="list-style-type: none"> <li>Clipping and clamping circuits, Stabilization Techniques, Voltage divider bias and its stability factor, Multistage amplifier, Darlington pair.</li> <li>Special Machines: Introduction to special electrical machines and its applications.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                      |                  |                             |             |
| <b>Targeted Application &amp; Tools that can be used:</b> <ul style="list-style-type: none"> <li>Targeted Applications: Application Area includes all electrical and electronic circuits (power supply unit, regulator unit, embedded devices, hardware electronics etc.). The students will be able to join a profession which involves basics to high level of electronic circuit design.</li> <li>Professionally Used Software: Multisim/ P Spice</li> <li>Besides these software tools hardware equipment such as Multimeters, Function Generators, Power Supplies, Oscilloscopes etc., can be used to perform component/circuit testing and analysis..</li> </ul>                                                                                                              |                                      |                  |                             |             |
| <b>Project Work/ Assignment:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                      |                  |                             |             |
| 1. Article review: At the end, of course an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format.<br>2. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.<br>3. Case Study: - At the end of the course students will be given a ‘real-world’ application based circuits like Power Amplifier, Signal/Function Generator etc. as a case study. Students will be submitting a report which will include Circuit Diagrams, Design, Working Mechanism and Results etc. in appropriate format |                                      |                  |                             |             |
| <b>Text Book(s):</b> <ul style="list-style-type: none"> <li>Kothari D. P. &amp; Nagrath I. J., “Basic Electrical and Electronics Engineering”, Tata McGraw-Hill Education</li> <li>Theraja B.L. and Theraja A.K., “A Textbook of Electrical Technology: Basic Electrical Engineering” in S.I. System of Units, 23rd ed., New Delhi: S. Chand, 2002.</li> <li>A.P.Malvino, Electronic Principles, 7th Edition, Tata McGraw Hill, 2007</li> <li>J. Millman, C. C. Halkias and C. D. Parikh, “Millman’s Integrated Electronics”, McGraw Hill Education, 2nd Edition.</li> </ul>                                                                                                                                                                                                        |                                      |                  |                             |             |

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| <ul style="list-style-type: none"> <li>Basics of Electrical &amp; Electronics Laboratory Manual.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |  |  |
| <p>Reference Book (s):</p> <ul style="list-style-type: none"> <li>John Hiley, Keith Brown and Ian McKenzie Smith, "HUGHES Electrical and Electronic Technology", 10th Edition (Indian Edition published by Dorling Kindersley), Pearson, 2011</li> <li>Samarajit Ghosh, "Fundamentals of Electrical and Electronics Engineering", 2nd Edition, Prentice Hall India, 2007.</li> <li>K Uma Rao, A Jaya Lakshmi, "Basic Electrical engineering" IK International publishing house Pvt. Ltd</li> <li>R. L. Boylestad and L. Nashelsky, "Electronic Devices and Circuit Theory", Pearson Education India 7th Edition.</li> <li>A K. Maini, V. Agrawal, "Electronic Devices &amp; Circuits", Wiley, 2nd Edition</li> <li>A.S Sedra, K. C. Smith, "Microelectronic Circuits", Oxford University Press, 6th Edition</li> <li>Online Resources (e-books, notes, ppts, video lectures etc.):</li> <li><a href="https://presidencyuniversity.linways.com">https://presidencyuniversity.linways.com</a></li> <li><a href="https://www.digimat.in/nptel/courses/video/108105112/L01">https://www.digimat.in/nptel/courses/video/108105112/L01</a> "Fundamentals of Electrical Engineering-Basic Concepts, Examples"</li> <li>Seminar Topic: <a href="https://nptel.ac.in/courses/108/105/108105153/">https://nptel.ac.in/courses/108/105/108105153/</a> "Electrical Measurements"</li> <li>Video lectures on "Electronic Devices" by Prof. Dr. A. N. Chandorkar, IIT Bombay <a href="http://www.satishkashyap.com/2013/03/video-lectures-on-electron-devices-by.html">http://www.satishkashyap.com/2013/03/video-lectures-on-electron-devices-by.html</a></li> <li>Video lectures on "Analog Electronics" by Prof. S.C. Dutta Roy, IIT Delhi <a href="https://nptel.ac.in/courses/108/102/108102095/">https://nptel.ac.in/courses/108/102/108102095/</a></li> <li>Video lectures on "Diodes", by Prof. Chitrakleha Mahanta, IIT Guwahati, <a href="https://nptel.ac.in/courses/117/103/117103063/">https://nptel.ac.in/courses/117/103/117103063/</a></li> <li>E-content:</li> <li>"Introduction to Electrical Machines <a href="https://nptel.ac.in/courses/108/102/108102146/">https://nptel.ac.in/courses/108/102/108102146/</a>"</li> <li>M. -Y. Kao, H. Kam and C. Hu, "Deep-Learning-Assisted Physics-Driven MOSFET Current Voltage Modeling," in IEEE Electron Device Letters, vol. 43, no. 6, pp. 974-977, June 2022, doi: 10.1109/LED.2022.3168243</li> <li><a href="https://ieeexplore-ieee-org-resiuniv.knimbus.com/document/9758727">https://ieeexplore-ieee-org-resiuniv.knimbus.com/document/9758727</a></li> <li>F. Bonet, O. Aviñó-Salvadó, M. Vellvehi, X. Jordà, P. Godignon and X. Perpiñà, "Carrier Concentration Analysis in 1.2 kV SiC Schottky Diodes Under Current Crowding," in IEEE Electron Device Letters, vol. 43, no. 6, pp. 938-941, June 2022, doi: 10.1109/LED.2022.3171112. <a href="https://ieeexplore-ieeeorg-presiuniv.knimbus.com/document/9764749">https://ieeexplore-ieeeorg-presiuniv.knimbus.com/document/9764749</a></li> <li>M. Chanda, S. Jain, S. De and C. K. Sarkar, "Implementation of Subthreshold Adiabatic Logic for Ultralow-Power Application," in IEEE Transactions on Very Large Scale Integration (VLSI) Systems, vol. 23, no. 12, pp. 2782-2790, Dec. 2015.</li> <li><a href="https://ieeexplore.ieee.org/document/7018053">https://ieeexplore.ieee.org/document/7018053</a></li> <li>R. Raut and O. Ghasemi, "A power efficient wide band trans-impedance amplifier in submicron CMOS integrated circuit technology," 2008 Joint 6th International IEEE Northeast Workshop on Circuits and Systems and TAISA Conference, 2008, pp. 113-116, doi: 0.1109/NEWCAS.2008.4606334. <a href="https://ieeexplore.ieee.org/document/4606334">https://ieeexplore.ieee.org/document/4606334</a></li> </ul> |  |  |  |
| <p>Topics relevant to "SKILL DEVELOPMENT": Performing suitable experiments to compute the electric circuit parameters, performance operation of machines, and operation of semiconductor devices for Skill Development through Participative Learning techniques. This is attained through assessment component mentioned in course plan.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |  |  |

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| <b>Course Code:</b><br>CSS2201 | <b>Course Title: Program Solving Using C Lab</b><br><b>Type of Course: Laboratory Course</b> | <b>L- T-P-C</b> | <b>0-0-4-2</b> |
| <b>Version No.</b>             | 1.0                                                                                          |                 |                |
| <b>Course Pre-requisites</b>   | NIL                                                                                          |                 |                |
| <b>Anti-</b>                   | NIL                                                                                          |                 |                |

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| <b>requisites</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Course Description</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | The course is designed to provide a strong foundation in the C programming language and problem-solving techniques. It enables students to develop logical thinking and programming skills required to design and implement applications using C. By understanding fundamental programming concepts such as algorithms, control structures, arrays, functions, pointers, and data handling, students will be prepared to learn and adapt to other programming languages and advanced computing technologies in the future.                                                                                                                                                                                                                                                                                                             |
| <b>Course Objective</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | The objective of the course is to familiarize the learners with the concepts of Problem Solving Using C and attain Employability through Problem Solving Methodologies.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <p><b>On successful completion of this course the students shall be able to:</b></p> <p><b>CO1:</b> Explain algorithms, flowcharts, and basic programming[Level 2 – Understand] concepts used in C programming.</p> <p><b>CO2:</b> Implement C programs using decision-making, looping[Level 3 – Apply] statements, arrays, and strings to solve computational problems.</p> <p><b>CO3:</b> Construct modular programs using functions, recursion, and[Level 3 – Apply] pointers for effective problem solving..</p> <p><b>CO4:</b> Develop applications using structures, unions, and file[Level 3 – Apply] handling concepts in C programming.</p> <p><b>CO5:</b> Design and implement simple real-world applications in[Level 3 – Apply] areas such as Cyber Security and Artificial Intelligence using C programming concepts.</p> |
| <b>Course Content:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <p><b>List of Practicals: 60 Sessions</b></p> <p><b>Lab Sheet 1: 10 Sessions</b></p> <p>Program 1: Sum of Two Numbers<br/> Program 2: Find the Greatest of Three Numbers<br/> Program 3: Check Even or Odd using Conditional Operator<br/> Program 4: Print Multiplication Table using Loop<br/> Program 5: Count Digits in a Number using While Loop<br/> Program 6: Demonstration of Preprocessor Directives<br/> Program 7: Simple Calculator using Switch Case</p> <p><b>Lab Sheet 2: 10 Sessions</b></p> <p>Program 1: Check Whether a Number is Positive, Negative or Zero<br/> Program 2: Find the Sum of First N Natural Numbers<br/> Program 3: Check Whether a Number is Prime or Not<br/> Program 4: Find Factorial of a Number<br/> Program 5: Reverse a Number<br/> Program 6: Simple Number Guessing Game</p> <p><b>Lab Sheet 3: 10 Sessions</b></p> <p>Program 1: Linear Search in a One-Dimensional Array<br/> Program 2: Bubble Sort on an Integer Array<br/> Program 3: Matrix Addition (2D Arrays)<br/> Program 4: Count Vowels in a String<br/> Program 6: Selection Sort on an Array</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

**Lab Sheet 4: 10 Sessions**

Program 1: Sum of Two Numbers Using User-Defined Function

Program 2: Factorial Using Recursion

Program 3: Swap Two Numbers Using Call by Value (No Swap)

Program 4: Swap Two Numbers Using Call by Reference (With Swap)

Program 5: Pointer Basics - Access and Modify Variable via Pointer

Program 6: Accessing Array Elements Using Pointers

**Lab Sheet 5: 10 Sessions**

Program 1: Basic Structure Usage

Program 2: Structure with Nested Structures (Date of Birth)

Program 3: Union Example and Member Access

Program 4: Write to a File (Text Mode)

Program 5: Read from a File (Text Mode)

Program 6: Append Data to a File

**Lab Sheet 6: 10 Sessions**

Program 1: Write a C program to check whether a password is strong or weak based on its length. If the password contains more than 8 characters, display "Strong Password"; otherwise display "Weak Password".

Program 2: Develop a simple login system using C. Store a predefined username and password in the program and verify the user input. Display "Login Successful" or "Invalid Credentials".

Program 3: Write a C program to input marks of 5 students and calculate the average marks. Display whether the class performance is "Good" or "Needs Improvement".

Program 4: Develop a C program to find the largest number in an array. This simulates basic data analysis used in AI systems.

**Text Book(s):**

1. E. Balaguruswamy, "Programming in ANSI C", 8th Edition, 2019, McGraw Hill Education, ISBN: 978-93-5316-513-0.

**Reference Book(s):**

1. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.
2. ReemaThareja, "Programming in C", Oxford University Press, Second Edition, 2016.
3. Kernighan, B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2015
4. Schildt Herbert, "C: The Complete Reference", Tata McGraw Hill Education, 4th Edition, 2014.
5. Stephen G. Kochan, "Programming in C", Addison-Wesley Professional, 4th Edition, 2014.

**Web Links and Video Lectures:**

1. [NPTEL – Programming in C](#)
2. [NPTEL – Problem Solving Through Programming in C](#)
3. [GeeksforGeeks – C Programming Language](#)
4. [Programiz – Learn C Programming](#)

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|-------------------------|---------------------------------------------------------------------------------------|-----------|---------|
| Course Code:<br>CHE2502 | Course Name: Chemistry of Smart<br>Materials Lab<br>Type of Course: Laboratory Course | L- T-P- C | 0-0-2-1 |
| Version No.             | 1.0                                                                                   |           |         |
| NCrF Level-             | 5.0                                                                                   |           |         |
| Course Pre-requisites   | NIL                                                                                   |           |         |

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| Co-requisites                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Anti-requisites                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Course Description                                                                            | The laboratory course aims to develop experimental skills and apply fundamental chemical principles to address chemistry-related problems in engineering. The experiments are carefully designed to complement the theoretical concepts covered in lectures, providing hands-on experience to deepen understanding and reinforce learning.<br>This course is designed to cater to Environment and Sustainability.                                                                                                                                               |
| Course Objective                                                                              | The objective of the course is to familiarize the learners with the concepts of “Chemistry of Smart Materials Lab” and attain SKILL DEVELOPMENT through EXPERIENTIAL LEARNING techniques.                                                                                                                                                                                                                                                                                                                                                                       |
| Course Outcomes                                                                               | On successful completion of the course, students shall be able to:<br>CO1: recognize the basic techniques and instrumentation used in chemistry laboratories for quantitative analysis.<br>CO2: estimate the presence of acids and metal ions in domestic and industrial waste using laboratory techniques.<br>CO3: review the experimental results and demonstrate improved experimental skills through hands-on laboratory experience.<br>CO4: classify laboratory techniques such as experimental setups for synthesis, purification, recovery and analysis. |
| Course Content:                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Experiment 1                                                                                  | Experimental Data Collection Analysis and Interpretation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Determination of strength of strong acid in battery electrolyte using conductometric sensors. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Experiment 2                                                                                  | Experimental Data Collection Analysis and Interpretation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Estimation of iron from e-waste using Electrochemical sensors.                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Experiment 3                                                                                  | Experimental Data Collection Analysis and Interpretation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Determination of pKa of organic acid of battery electrolyte using pH sensor.                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Experiment 4                                                                                  | Experimental Data Collection Analysis and Interpretation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Estimation of copper from PCBs by using colorimeter (Optical Sensor).                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

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| Course Code: PPS1026  | Course Title: Industry Readiness Program – II<br>Type of Course: Practical Only Course                                                                                                                                                                                                      | L-T- P- C | 0 | 0 | 2 | 0 |
| Version No.           | 1.0                                                                                                                                                                                                                                                                                         |           |   |   |   |   |
| Course Pre-requisites | Students are expected to understand basic English.<br>Students should have desire and enthusiasm to get involved, participate, and learn.                                                                                                                                                   |           |   |   |   |   |
| Anti-requisites       | NIL                                                                                                                                                                                                                                                                                         |           |   |   |   |   |
| Course Description    | This course is designed to enable students to set SMART goals, form professional & personal ethics for the success and learn various email writing techniques. The course will benefit learners in presenting themselves effectively through various activities and learning methodologies. |           |   |   |   |   |
| Course Objective      | The objective of the course is to familiarize the learners with the concepts of “Employability for Young Professionals” and attain SKILL DEVELOPMENT through PARTICIPATIVE LEARNING techniques.                                                                                             |           |   |   |   |   |
| Course Outcomes       | On successful completion of the course the students shall be able to:<br><b>CO1:</b> Apply different communication skills for success in [Level 3 - Apply] workplace<br><b>CO2:</b> Practice team building skills for career success [Level 3 - Apply]                                      |           |   |   |   |   |

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|                                                                                          | <b>CO3: Demonstrate ethical leadership skills in workplace</b> [Level 3 - Apply] |                      |             |
| Course Content:                                                                          |                                                                                  |                      |             |
| Module 1                                                                                 | Effective Communication                                                          | Classroom activities | 10 Sessions |
| Topics: Practice effective communication skills (Verbal, Non-verbal, Written and Visual) |                                                                                  |                      |             |
| Activity: Use social media prompts to prepare self-introduction videos                   |                                                                                  |                      |             |
| Module 2                                                                                 | Team Building                                                                    | Group Activity       | 10 Sessions |
| Topics: Skills of an effective team player                                               |                                                                                  |                      |             |
| Activity: Student group activity to build class networking                               |                                                                                  |                      |             |
| Module 3                                                                                 | Leadership                                                                       | Case study           | 10 Sessions |
| Topics: Types of leadership, using empathy in leadership                                 |                                                                                  |                      |             |
| Activity: Individual presentation by students on corporate leaders.                      |                                                                                  |                      |             |
| Targeted Applications & Tools:                                                           |                                                                                  |                      |             |
| TED Talks; You Tube Links; Activities                                                    |                                                                                  |                      |             |
| Assignment proposed for this course                                                      |                                                                                  |                      |             |
| Assignment 1: One minute reel                                                            |                                                                                  |                      |             |
| Assignment 2: Team building assignment                                                   |                                                                                  |                      |             |
| Continuous Individual Assessment                                                         |                                                                                  |                      |             |
| Module 1: L-S-R-W class assessment                                                       |                                                                                  |                      |             |
| Module 2: Team Presentation                                                              |                                                                                  |                      |             |
| Module 3: Individual Assessment                                                          |                                                                                  |                      |             |

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| <b>Course Code:</b><br>EEE1251                      | <b>Course Title: Basics of Electrical and Electronics Engineering Laboratory</b><br><b>Type of Course: ESC - Laboratory</b>                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>L-T-P- C</b> | 0 | 0 | 2 | 1 |
| <b>Version No.</b>                                  | <b>1.0</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |   |   |   |   |
| <b>Course Pre-requisites</b>                        | <b>Nil</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |   |   |   |   |
| <b>Anti-requisites</b>                              | <b>Nil</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |   |   |   |   |
| <b>Course Description</b>                           | This fundamental laboratory provides an opportunity to validate the concepts taught in the basics of electrical and electronics engineering and enhances the ability to visualize real system performance, using both hardware and simulation tools.                                                                                                                                                                                                                                                                                              |                 |   |   |   |   |
| <b>Course Objective</b>                             | The objective of the course is to familiarize the learners with the concepts of Basics of Electrical and Electronics Engineering and attain Skill Development through Experiential Learning techniques.                                                                                                                                                                                                                                                                                                                                           |                 |   |   |   |   |
| <b>Basic skill sets required for the laboratory</b> | <b>The students shall be able to develop:</b> <ol style="list-style-type: none"> <li>1) An attitude of enquiry.</li> <li>2) Confidence and ability to tackle new problems.</li> <li>3) Ability to interpret events and results.</li> <li>4) Ability to work as a leader and as a member of team.</li> <li>5) Assess errors and eliminate them.</li> <li>6) Observe and measure physical phenomenon.</li> <li>7) Write Reports.</li> <li>8) Select suitable equipment, instruments and materials.</li> <li>9) Locate faults in systems.</li> </ol> |                 |   |   |   |   |

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|                        | 10) Skills for setting and handling equipment.<br>11) The ability to follow standard test procedures.<br>12) An awareness of the need to observe safety precautions.<br>13) To judge magnitudes without actual measurement.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Course Outcomes</b> | On successful completion of the course, the students shall be able to: <ol style="list-style-type: none"> <li>1. <b>Demonstrate</b> the behavior of passive elements and fundamental electrical circuit laws</li> <li>2. <b>Determine</b> the power factor, impedance, and phase relationship of R and RL loads under AC supply conditions.</li> <li>3. <b>Develop</b> electrical circuits and three-phase supply systems using MATLAB/Simulink to study resistance, voltage, and current characteristics.</li> <li>4. <b>Analyze</b> the performance characteristics of electrical machines, including single-phase transformers and three-phase induction motors, under different operating conditions.</li> <li>5. <b>Examine</b> the output characteristics and performance parameters of half-wave and full-wave rectifiers.</li> <li>6. <b>Illustrate</b> the performance characteristics of Zener diode and MOSFET under different operating conditions.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Course Content:</b> | List of Laboratory Tasks:<br><b>Experiment No 1:</b> Familiarization of passive elements.<br><br>Level 1: Identify and understand the function and ratings of basic passive elements.<br>Level 2: Study the behavior of passive elements in simple electrical circuits by measuring voltage, current, and impedance.<br><b>Experiment No 2:</b> Experimental Verification of Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL).<br>Level 1: Study and Verify KVL and KCL for the given electrical Circuit.<br><b>Experiment No 3:</b> Determination of Power Factor, and Impedance for R and RL Loads.<br>Level 1: Determine the power factor and impedance of R and RL loads under steady-state AC supply conditions.<br>Level 2: Analyze the effect of inductance on power factor, impedance, and phase angle for RL loads under varying load conditions.<br><b>Experiment No 4:</b> Modeling and Simulation of effective resistances in different circuit connections Using Simulink.<br>Level 1: Model and simulate series and parallel resistor circuits in Simulink and determine their effective resistance.<br>Level 2: Analyze the effect of different resistor combinations on total resistance, current distribution, and voltage drop.<br><b>Experiment No 5:</b> Simulation and analysis of line and phase voltages in Star-connected and Delta- connected supply systems.<br>Level 1: Model and simulate star-connected and delta-connected three-phase supply systems and observe line and phase voltages.<br>Level 2: Analyze and compare the relationship between line and phase voltages in star and delta connections.<br><b>Experiment 6:</b> Determination of transformation ratio of a Single-Phase Transformer Under different tapping conditions.<br>Level 1: Determine the transformation ratio of a single-phase transformer under no-load condition for various tap settings.<br>Level 2: Analyze the effect of different tapping conditions on secondary voltage, regulation, and transformer performance.<br><b>Experiment No. 7:</b> Study of the speed-torque characteristics of a Three-Phase Induction Motor. |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <p>Level 1: Study and analyze the speed–torque characteristics of a three-phase induction motor.</p> <p>Level 2: Evaluate the effect of supply voltage and current on motor performance parameters such as slip, and torque.</p> <p><b>Experiment 8:</b> Performance Analysis of Half-Wave and Full-Wave Rectifier Circuits Using Simulink.</p> <p>Level 1: Model and simulate half-wave and full-wave rectifier circuits in Simulink and analyze their output waveforms.</p> <p>Level 2: Evaluate and compare rectifier performance parameters such as ripple factor, efficiency, and output voltage.</p> <p><b>Experiment 9:</b> Study of the characteristics of a Zener Diode.</p> <p>Level 1: Study the forward and reverse V–I characteristics of a Zener diode using DC analysis.</p> <p>Level 2: Analyze the Zener breakdown characteristics and determine the Zener voltage and regulation behavior.</p> <p><b>Experiment 10:</b> Study of the Output and Transfer Characteristics of a MOSFET.</p> <p>Level 1: Study, analyze and implement the output characteristics of a MOSFET under different gate-source voltage conditions and observe their results.</p> <p>Level 2: Analyze the transfer characteristics of a MOSFET and evaluate key parameters such as threshold voltage and transconductance.</p> |
| <p><b>Targeted Application &amp; Tools that can be used:</b></p> <p><b>Targeted Applications:</b> Application area includes all electrical and electronic circuits (power supply unit, regulator unit, embedded devices, hardware electronics etc.). The students will be able to join a profession which involves basics to high level of electronic circuit design.</p> <p>Professionally Used Software: MATLAB SIMULINK</p> <p>Besides these software tools hardware equipment such as Multimeters, Function Generators, Power Supplies, Oscilloscopes etc., can be used to perform component/circuit testing and analysis.</p>                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <p><b>Course Material</b></p> <ol style="list-style-type: none"> <li>Basics of Electrical and Electronics Engineering Laboratory Manual, Presidency University, Bengaluru.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <p><b>Text Book:</b></p> <ol style="list-style-type: none"> <li>D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering, 4th Edition, McGraw Hill Education, New Delhi, 2019.</li> <li>B. L. Theraja and A. K. Theraja, A Textbook of Electrical Technology, Volume-I: Basic Electrical Engineering in SI Units, 24th Edition, S. Chand Publishing, New Delhi, 2024.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <p><b>References</b></p> <ol style="list-style-type: none"> <li>John Hiley, Keith Brown and Ian McKenzie-Smith, Hughes Electrical and Electronic Technology, 12th Edition, Pearson Education, 2016.</li> <li>S. K. Bhattacharya and D. Devaraj, Basic Electrical and Electronics Engineering, 2nd Edition, Pearson Education India, 2017.</li> <li>T. K. Nagsarkar and M. S. Sukhija, Principles of Basic Electrical Engineering, 1st Edition, Oxford University Press, 2018.</li> <li>Robert L. Boylestad and Louis Nashelsky, Electronic Devices and Circuit Theory, 12th Edition, Pearson Education, 2019.</li> <li>A. K. Maini and Varsha Agrawal, Electronic Devices and Circuits, 2nd Edition, Wiley India, 2019.</li> <li>Adel S. Sedra and Kenneth C. Smith, Microelectronic Circuits, 8th Edition, Oxford University Press, 2019.</li> </ol> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <p><b>Online Resources:</b></p> <ol style="list-style-type: none"> <li><a href="https://presidencyuniversity.linways.com">https://presidencyuniversity.linways.com</a></li> <li><a href="https://www.digimat.in/nptel/courses/video/108105112/L01">https://www.digimat.in/nptel/courses/video/108105112/L01</a> “Fundamentals of Electrical Engineering - Basic Concepts, Examples”</li> <li>Video lectures on “Electronic Devices” by Prof. Dr. A. N. Chandorkar, IIT Bombay</li> </ol>                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

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| <a href="http://www.satishkashyap.com/2013/03/video-lectures-on-electron-devices-by.html">http://www.satishkashyap.com/2013/03/video-lectures-on-electron-devices-by.html</a><br>4. NPTEL lectures on “Rectifiers”, by Prof. G. Bhuvaneswari, IIT Delhi<br><a href="https://nptel.ac.in/courses/108102145">https://nptel.ac.in/courses/108102145</a><br>5. NPTEL Lectures on “Electrical Machines II”, by Prof. G. Sridhara Rao, IIT Madras.<br><a href="https://nptel.ac.in/courses/108106072">https://nptel.ac.in/courses/108106072</a> |  |
| <b>Topics relevant to “EMPLOYABILITY SKILLS”:</b> All the experiments which are listed are for <b>Skill Development</b> through <b>Experiential Learning Techniques</b> . This is attained through the assessment component mentioned in course handout.<br><b>Topics relevant to “HUMAN VALUES &amp; PROFESSIONAL ETHICS”:</b> Standard test methods, safety procedure.                                                                                                                                                                  |  |
| <b>Catalogue prepared by</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |
| <b>Recommended by the Board of Studies on</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |
| <b>Date of Approval by the Academic Council</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |

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| Course Code:<br>CIV7601 | Course Title: Universal Human Values and Ethics<br>Type of Course: MAC course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | L-T-P-C           | 1-0-0-0             |
| Course Pre-requisites   | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   |                     |
| Anti-requisites         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   |                     |
| Course Description      | <p>The purpose of the course is to develop a holistic perspective in students’ life. The course adopts a self-reflective methodology of teaching and is designed to equip the students to explore their role in all aspects of living as a part of the society. It presents a universal approach to value education by developing the right understanding of reality through the process of self-exploration.</p> <p>This self-exploration develops more confidence and commitment in students enabling them to critically evaluate their pre-conditioning and present beliefs. As an outcome of the holistic approach, the students will be able to practice the ethical conduct in the social and professional life. The prime focus throughout the course is toward affecting a qualitative transformation in the life of the student rather than just a transfer of information.</p> <p>This course is designed to cater to Human Values and Professional Ethics.</p> |                   |                     |
| Course Objective        | The objective of the course is ‘SKILL DEVELOPMENT’ of the student by using ‘SELF LEARNING’ techniques                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |                     |
| Course Outcomes         | <p>On successful completion of this course the students shall be able to:</p> <p>CO1: Understand the concepts of human values, self-exploration, [Level 2 – Understand] and holistic development in personal and social contexts.</p> <p>CO2: Apply principles of human values and ethical conduct in [Level 3 – Apply] personal, social, and professional life situations.</p> <p>CO3: Apply the concepts of harmony and ethical reasoning to [Level 3 – Apply] address issues in family, society, and professional environments.</p> <p>CO4: Analyze the relationship between self and body, and the role [Level 4 – Analyze] of values in maintaining harmony within individuals and society.</p> <p>CO5: Evaluate personal beliefs, behaviors, and professional [Level 5 – Evaluate] practices based on universal human values and ethical principles.</p>                                                                                                            |                   |                     |
| Course Content:         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                   |                     |
| Module 1                | Introduction to Value Education                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Online Assessment | MCQ Quiz 5 Sessions |

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| <p>Topics:<br/>Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education), Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfil the Basic Human Aspirations.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                            |                   |          |            |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Harmony in the Human Being                                                 | Online Assessment | MCQ Quiz | 5 Sessions |
| <p>Topics:<br/>Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                            |                   |          |            |
| Module 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Harmony in the Family and Society                                          | Online Assessment | MCQ Quiz | 5 Sessions |
| <p>Topics:<br/>Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                            |                   |          |            |
| Module 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Implications of the Holistic Understanding – A Look at Professional Ethics | Online Assessment | MCQ Quiz | 5 Sessions |
| <p>Topics:<br/>Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Holistic Technologies, Strategies for Transition towards Value-based Life and Profession</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                            |                   |          |            |
| <p>Targeted Application &amp; Tools that can be used:<br/>Application areas are Personal life, Education and Career, Workplace , Society and Environmental Responsibility<br/>Tools: Online Tools – NPTEL and Swayam.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                            |                   |          |            |
| Project work/Assignment:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                            |                   |          |            |
| <p>Assessment Type</p> <ul style="list-style-type: none"> <li>Online exams (MCQs) will be conducted by the Department of Civil Engineering through Linways.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                            |                   |          |            |
| <p>Online Link*:</p> <ol style="list-style-type: none"> <li>UHV <span style="float: right;">II</span><br/><a href="https://www.youtube.com/watch?v=NhFBzn5qKIM&amp;list=PLWDeKF97v9S08vvjC1KyqteziTbTjN1So&amp;pp=0gcJCWMEOCosWNin">https://www.youtube.com/watch?v=NhFBzn5qKIM&amp;list=PLWDeKF97v9S08vvjC1KyqteziTbTjN1So&amp;pp=0gcJCWMEOCosWNin</a></li> <li>Lecture by Dr. Kumar Sambhav, NPTEL course: Universal Human Values, <a href="https://onlinecourses.swayam2.ac.in/aic22_ge23/preview">https://onlinecourses.swayam2.ac.in/aic22_ge23/preview</a></li> <li>Lecture by Dr. Padmavati, Dr Narendran Thiruthy, NPTEL Course: Biodiversity Protection, Farmers and Breeders Rights, <a href="https://nptel.ac.in/courses/129105008">https://nptel.ac.in/courses/129105008</a>, 2024.</li> </ol> <p>* Other source links are available in below Resources link.</p> |                                                                            |                   |          |            |
| <p>Text Book</p> <ol style="list-style-type: none"> <li>A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1</li> <li>Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2019.</li> <li>Premvir Kapoor, Professional Ethics and Human Values, Khanna Book Publishing, New Delhi, 2022.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                            |                   |          |            |
| <p>Reference Books</p> <ol style="list-style-type: none"> <li>E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond &amp; Briggs, Britain.</li> <li>Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986.</li> <li>Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome’s report, Universe Books.</li> <li>A Nagraj, 1998, Jeevan Vidya Ek Parichay, Divya Path Sansthan, Amarkantak.</li> </ol>                                                                                                                                                                                                                                                                                                                                                |                                                                            |                   |          |            |

5. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
6. A N Tripathy, 2003, Human Values, New Age International Publishers.
7. E G Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers, Oxford University Press
8. M Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
9. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
10. William P. Cunningham and Mary Ann Cunningham (2020), Principles of Environmental Science: Inquiry & Applications, 9<sup>th</sup> Edition, McGraw-Hill Education, USA.

**Resources:**

1. [https://onlinecourses.swayam2.ac.in/imb25\\_mg195/preview](https://onlinecourses.swayam2.ac.in/imb25_mg195/preview)
2. [https://onlinecourses.nptel.ac.in/noc25\\_mg141/preview](https://onlinecourses.nptel.ac.in/noc25_mg141/preview)
3. [https://onlinecourses.swayam2.ac.in/ini25\\_hs52/preview](https://onlinecourses.swayam2.ac.in/ini25_hs52/preview)
4. [https://onlinecourses.nptel.ac.in/noc25\\_hs219/preview](https://onlinecourses.nptel.ac.in/noc25_hs219/preview)
5. [https://onlinecourses.swayam2.ac.in/cec25\\_mg14/preview](https://onlinecourses.swayam2.ac.in/cec25_mg14/preview)
6. [https://onlinecourses.swayam2.ac.in/imb25\\_mg195/preview](https://onlinecourses.swayam2.ac.in/imb25_mg195/preview)
7. [https://onlinecourses.swayam2.ac.in/imb25\\_mg196/preview](https://onlinecourses.swayam2.ac.in/imb25_mg196/preview)

**Topics relevant to Skill Development:**

1. An attitude of enquiry.
2. Write reports

The topics related to Human values and Professional ethics:

All topics in are relevant to Human values and Professional ethics.

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| <b>Course Code:</b><br>MAT2311 | <b>Course Title:</b> Vector Calculus, Numerical Methods and Sampling Distributions<br>[Type of Course:1] School Core                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | - P- C | 3 | 1 | 0 | 4 |
| <b>Version No.</b>             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |   |   |   |   |
| <b>Course Pre-requisites</b>   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |   |   |   |   |
| <b>Anti-requisites</b>         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |   |   |   |   |
| <b>Course Description</b>      | This course introduces the fundamental concepts and methods of ordinary differential equations, numerical techniques, and statistical inference used in engineering and scientific applications. The course covers analytical methods for solving differential equations, numerical methods for solving linear and nonlinear equations, interpolation, numerical differentiation and integration, and numerical solutions of ordinary differential equations. It also introduces sampling distributions and hypothesis testing for statistical decision-making. The course enables students to apply mathematical and statistical techniques to solve computational and real-world engineering problems.                                                                           |        |   |   |   |   |
| <b>Course Objective</b>        | The objectives of this course are to develop the ability to solve ordinary differential equations arising in scientific and engineering applications. Introduce numerical techniques for solving systems of linear equations and nonlinear algebraic equations. Apply interpolation, differentiation, and integration methods for approximating mathematical functions and evaluating definite integrals. Employ numerical methods for obtaining approximate solutions of ordinary differential equations. Apply concepts of sampling distributions and statistical inference to estimate population parameters and support decision-making. Apply hypothesis testing techniques to real-world problems involving means, proportions, variances, and associations among variables. |        |   |   |   |   |

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| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | After successful completion of the course, students will be able to:<br><b>CO1:</b> Employ vector differential operators to solve problems involving scalar and vector fields and classify them as solenoidal or irrotational (L3)<br><b>CO2:</b> Apply vector integration techniques and integral theorems to a solve engineering problems. (L3)<br><b>CO3:</b> Use numerical methods to solve systems of linear and nonlinear equations. (L3)<br><b>CO4:</b> Implement numerical techniques for interpolation, differentiation, integration, and ordinary differential equations. (L3)<br><b>CO5:</b> Utilize sampling distributions and statistical inference techniques to solve statistical problems. (L3)<br><b>CO6:</b> Perform hypothesis testing for statistical decision-making. (L3) |                             |
| <b>Course Content:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                             |
| <b>Module 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Vector Calculus</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>(14L+5T=19 Sessions)</b> |
| Vector & Scalar Functions and Fields, Derivatives, Curve, Arc length, Curvature & Torsion, Gradient of Scalar Field, Directional Derivative, Divergence of a Vector Field, Curl of a Vector Field, Physical interpretation, Solenoidal and Irrotational Vector Fields. Problems.<br>Line Integrals, Path Independence of Line Integrals, Surface and Volume Integrals, Green's Theorem in the plane, Divergence Theorem of Gauss, Stokes's Theorem. Problems on Image Edge Detection, Robot Path Planning and 3D Surface Modelling                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                             |
| <b>Module 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Solution of Linear Systems and non-linear of Equation</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>(9L+3T=12 Sessions)</b>  |
| Introduction, Jacobi iteration method, Gauss-Seidel iteration method. Solution of Algebraic and Transcendental Equations: Bisection method, Regula-Falsi method, Newton-Raphson method, secant method, fixed point iteration method.<br>Page Ranking, Network Analysis, Circuit Simulation, Root Finding, Load Balancing, and Computational Optimization Problems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                             |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Numerical Interpolations and Differential Equations</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>(10L+3T=13 Sessions)</b> |
| Newton's method, Divided difference method, Lagrange's method, Numerical differentiation, Numerical integration: Trapezoidal rule, Simpson's one-third rule, Simpson's three-eighth rule, Gaussian quadrature rule. Solution of ordinary differential equations: Taylor series method, modified Euler's method, Runge-Kutta method for 4th order. Problems on Signal Reconstruction, Sensor Data Interpolation and Trajectory Prediction.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                             |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Sampling Distributions</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>(12L+4T=16 Sessions)</b> |
| Random sampling, sampling distributions, Standard Error, Type I & Type II errors, Testing of Hypothesis, Test of significance - Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations, Test for single mean, difference of means, test for ratio of variances - Chi-square test for goodness of fit and independence of attributes. A/B Testing, Fraud Detection, Spam Classification Evaluation, and Network Traffic Analysis.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                             |
| Targeted Applications & Mathematical Tools: <ul style="list-style-type: none"> <li>• Analysis of fluid flow in open channels and pipelines, groundwater movement, stress and strain fields, terrain modelling, and 3D surface representation in civil engineering projects.</li> <li>• Structural analysis, load distribution in trusses and frames, hydraulic network analysis, foundation design computations, and optimization problems in transportation and water resource systems.</li> <li>• Estimation of terrain elevations, survey data interpolation, rainfall-runoff modelling, settlement prediction, traffic flow analysis, and numerical solutions of engineering differential equations.</li> <li>• Quality control of construction materials, reliability analysis, traffic studies, environmental data analysis, hydrological investigations, and hypothesis testing in engineering experiments.</li> <li>• Analysis of vector fields in fluid flow, electromagnetics, and heat transfer; image edge detection, robot path planning, and 3D surface modelling using gradients, divergence, curl, and integral theorems.</li> </ul> Software: MATLAB, Python, Microsoft Excel Solver, LINDO/LINGO, AutoCAD, ETABS, Scilab. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                             |
| <b>Assignment:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                             |

Assignments will involve theoretical problem-solving and computational implementation using suitable programming tools. The assignments may be undertaken individually or in groups, as decided by the instructor.

#### **Text Book**

1. M. K. Jain, S. R. K. Iyengar, and R. K. Jain, *Numerical Methods for Scientific and Engineering Computation*, 7th ed. New Delhi, India: New Age International Publishers, 2019.
2. B. S. Grewal, *Higher Engineering Mathematics*, 45th ed. New Delhi, India: Khanna Publishers, 2022.
3. S. C. Gupta and V. K. Kapoor, *Fundamentals of Mathematical Statistics*, 12th ed. New Delhi, India: Sultan Chand & Sons, 2020.

#### **References:**

1. M. K. Jain, S. R. K. Iyengar, and R. K. Jain, *Numerical Methods for Scientific and Engineering Computation*, 7th ed. New Delhi, India: New Age International Publishers, 2019.
2. S. S. Sastry, *Introductory Methods of Numerical Analysis*, 5th ed. New Delhi, India: PHI Learning Pvt. Ltd., 2012.
3. J. Kiusalaas, *Numerical Methods in Engineering with Python 3*, 3rd ed. Cambridge, U.K.: Cambridge University Press, 2025.
4. D. C. Montgomery and G. C. Runger, *Applied Statistics and Probability for Engineers*, 8th ed. Hoboken, NJ, USA: John Wiley & Sons, 2023.
5. D. D. Wackerly, W. Mendenhall, and R. L. Scheaffer, *Mathematical Statistics with Applications*, 7th ed. Belmont, CA, USA: Cengage Learning, 2008.
6. E. Kreyszig, *Advanced Engineering Mathematics*, 10th ed. Hoboken, NJ, USA: John Wiley & Sons, 2011.
7. R. L. Burden, J. D. Faires, and A. M. Burden, *Numerical Analysis*, 11th ed. Boston, MA, USA: Cengage Learning, 2021.
8. S. C. Chapra, *Applied Numerical Methods with MATLAB for Engineers and Scientists*, 4th ed. New York, NY, USA: McGraw-Hill Education, 2018.

#### **E-resources/ Web links:**

1. <https://presiuniv.knimbus.com/portal/v2/default/viewDetail?searchResultType=ECATALOGUE BASED&uniqueId=CUSTOM PACKAGE EBSCO 29052023 53751>
2. <https://presiuniv.knimbus.com/portal/v2/default/viewDetail?searchResultType=ECATALOGUE BASED&uniqueId=TEXTBOOK LIBRARY01 06082022 117>
3. <https://presiuniv.knimbus.com/portal/v2/default/viewDetail?searchResultType=ECATALOGUE BASED&uniqueId=DOAB 1 06082022 7313>
4. <https://presiuniv.knimbus.com/portal/v2/default/viewDetail?searchResultType=ECATALOGUE BASED&uniqueId=CUSTOM PACKAGE EBSCO 29052023 228965>
5. <https://presiuniv.knimbus.com/portal/v2/default/viewDetail?searchResultType=ECATALOGUE BASED&uniqueId=DOAB 1 06082022 8838>
6. <https://presiuniv.knimbus.com/portal/v2/default/viewDetail?searchResultType=ECATALOGUE BASED&uniqueId=SPRINGER OPEN ACCESS BOOKS 10022025 1861>
7. <https://presiuniv.knimbus.com/portal/v2/default/viewDetail?searchResultType=ECATALOGUE BASED&uniqueId=DOAB 1 06082022 7312>

**Topics relevant to SKILL DEVELOPMENT:** Identification and solution of differential equations, application of numerical methods for algebraic and differential equations, implementation of interpolation and numerical integration techniques, statistical data analysis and hypothesis testing, and use of Python/MATLAB for engineering problem solving.

|                                                 |                        |
|-------------------------------------------------|------------------------|
| <b>Catalogue prepared by</b>                    | <b>Dr. V Ramalatha</b> |
| <b>Recommended by the Board of Studies on</b>   |                        |
| <b>Date of Approval by the Academic Council</b> |                        |

|                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                             |             |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|-------------|
| Course Code:<br>CSS2251                                                                                                                                                                                                                                                                               | Course Name: Data Communications<br>and Computer Networks<br>Type of Course: Theory Course                                                                                                                                                                                                                                                                                                                                                                                                                            | L- T-P- C                                   | 3-0-0-3     |
| Version No.                                                                                                                                                                                                                                                                                           | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                             |             |
| Course Pre-requisites                                                                                                                                                                                                                                                                                 | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                             |             |
| Co-requisites                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                             |             |
| Anti-requisites                                                                                                                                                                                                                                                                                       | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                             |             |
| Course Description                                                                                                                                                                                                                                                                                    | The objective of this course is to provide knowledge in data communications and computer networks, its organization and its implementation, and gain practical experience in the installation, monitoring, and troubleshooting of LAN systems. . The associated laboratory is designed to implement and simulate various networks using Cisco packet tracer, NS2. All the lab exercises will focus on the fundamentals of creating multiple networks, topologies and analyzing the network traffics.                  |                                             |             |
| Course Objective                                                                                                                                                                                                                                                                                      | The objective of the course is to familiarize the learners with the concepts of Data Communications and Computer Networks and attain Employability through Problem Solving Methodologies.                                                                                                                                                                                                                                                                                                                             |                                             |             |
| Course Outcomes                                                                                                                                                                                                                                                                                       | <b>On successful completion of the course the students shall be able to:</b><br><br><b>CO1:</b> Illustrate The Basic Concepts Of Data Communication[Level 3 - Apply] And Computer Networks.<br><b>CO2:</b> Analyze the functionalities of the Data Link Layer. [Level 4 – Analyze]<br><b>CO3:</b> Apply the Knowledge of IP Addressing and Routing[Level 3 – Apply] Mechanisms in Computer Networks.<br><b>CO4:</b> Demonstrate the working principles of the Transport[Level 3 – Apply] layer and Application Layer. |                                             |             |
| Course Content:                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                             |             |
| Module 1                                                                                                                                                                                                                                                                                              | Introduction and Physical layer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Assessment: Assignment<br>(Problem Solving) | 9 Sessions  |
| Topics:<br>Introduction to Computer Networks and Data communications, Network Components – Topologies, Transmission Media –Reference Models - TCP/IP Suite, OSI Model .<br>Physical Layer -Analog and Digital Signals – Digital and Analog Signals – Transmission - Multiplexing and Spread Spectrum. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                             |             |
| Module 2                                                                                                                                                                                                                                                                                              | Data Link Layer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Assessment: Assignment<br>(Problem Solving) | 12 Sessions |
| Topics:<br>Data Link Layer - Error Detection and Correction– Parity, CRC, Hamming Distance Flow Control and Error Control, Stop and Wait, Multiple Access Protocols, CSMA/CD,CSMA/CA                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                             |             |
| Module 3                                                                                                                                                                                                                                                                                              | Network Layer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Assessment: Assignment<br>(Problem Solving) | 13 Sessions |
| Topics:<br>Network Layer Services - Network Layer Services, Switching Techniques, IP Addressing methods- IPv4 IPV6 – Subnetting. Routing, - Distance Vector Routing, Link State Routing, RIP, OSPF, BGPV4.                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                             |             |
| Module 4                                                                                                                                                                                                                                                                                              | Transport and Application Layer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Assessment: Assignment<br>(Problem Solving) | 11 Sessions |
| Topics:<br>Transport Layers - Connection management – Flow control-Sliding Window, Go-Back N ARQ, Selective Repeat ARQ, UDP, TCP, congestion control, Congestion avoidance The Application Layer: Domain Name                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                             |             |

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| System (DNS), Domain Name Space, FTP, Electronic Mail (SMTP), HTTP.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Targeted Applications & Tools: Cisco Packet Tracer, Wireshark, and NS2 Simulator.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Skill-Building Activities through Experiential Learning:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Text Book<br><b>T1:</b> T1. Behrouz A. Forouzan, “Data Communications and Networking with TCP/IP Protocol Suite”, 6th Edition, Tata McGraw-Hill, 2022.<br><b>T2:</b> Andrew S Tanenbaum, Nick Feamster & David J Wetherall, “Computer Networks” Sixth Edition, Pearson Publication, 2022.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| References<br><b>R1:</b> “Computer Networking: A Top-Down Approach”, Eighth Edition, James F. Kurose, Keith W. Ross, Pearson publication, 2021.<br><b>R2:</b> William Stallings, Data and Computer Communication, 8th Edition, Pearson Education, 2007.<br><b>R3:</b> Behrouz A. Forouzan, “Data Communications and Networking 5E”, 5th Edition, Tata McGraw-Hill, 2012                                                                                                                                                                                                                                                                                                                                                                                                                     |
| E-Resources/Web Resources<br>1. <a href="https://www.geeksforgeeks.org/what-is-spread-spectrum/">https://www.geeksforgeeks.org/what-is-spread-spectrum/</a><br>2. <a href="https://www.geeksforgeeks.org/difference-between-fdma-tdma-and-cdma/">https://www.geeksforgeeks.org/difference-between-fdma-tdma-and-cdma/</a><br>3. <a href="https://archive.nptel.ac.in/courses/106/105/106105183/">https://archive.nptel.ac.in/courses/106/105/106105183/</a><br>4. <a href="http://www.nptelvideos.com/course.php?id=393">http://www.nptelvideos.com/course.php?id=393</a><br>5. <a href="https://www.digimat.in/keyword/106.html">https://www.digimat.in/keyword/106.html</a> <a href="https://puniversity.informaticsglobal.com/login">https://puniversity.informaticsglobal.com/login</a> |

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|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|---|---|---|---|
| Course Code:<br>CSS2278 | Course Title: Data Structures and Analysis of Algorithms<br>Type of Course: Theory Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | L-T- P- C | 3 | 1 | 0 | 4 |
| Version No.             | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           |   |   |   |   |
| Course Pre-requisites   | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           |   |   |   |   |
| Anti-requisites         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           |   |   |   |   |
| Course Description      | This course provides a comprehensive introduction to the fundamental concepts of data structures and algorithm analysis, which are essential for efficient problem solving in computer science. It covers the design, implementation, and application of linear and non-linear data structures such as arrays, linked lists, stacks, queues, trees, and graphs. The course also emphasizes the analysis of algorithms using asymptotic notations, enabling students to evaluate the efficiency of different approaches. Additionally, students are introduced to basic algorithm design techniques such as divide and conquer and greedy methods, equipping them with the skills required to develop optimized and scalable solutions for real-world computational problems. |           |   |   |   |   |
| Course Objective        | To develop the ability to implement various data structures and apply them in practical scenarios. The course also focuses on building analytical skills to evaluate algorithm performance using time and space complexity measures. Furthermore, it introduces fundamental algorithm design strategies, helping students to analyze, compare, and choose suitable techniques for problem solving in diverse computing applications.                                                                                                                                                                                                                                                                                                                                         |           |   |   |   |   |
| Course Outcomes         | <b>On successful completion of this course, students will be able to:</b><br><b>CO1:</b> Explain fundamental data structures and algorithmic concepts, including time and space complexity. [Level 2 - Understand]<br><b>CO2:</b> Implement linear data structures (arrays, linked lists, stacks, queues) to solve computational problems. [Level 2 - Understand]                                                                                                                                                                                                                                                                                                                                                                                                            |           |   |   |   |   |

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|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|------------|
|                                                                                                                                                                                                                                                                                                                                                                                                   | <b>C03:</b> Apply tree and graph structures for efficient data[Level 3 – Apply] representation and traversal.<br><b>C04:</b> Analyze algorithms using asymptotic notations and compare[Level 4 – Analyze] their efficiencies.<br><b>C05:</b> Evaluate and select appropriate data structures and[Level 4 – Analyze] algorithmic techniques for real-world problem -solving. |                 |            |
| Course Content:                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                             |                 |            |
| Module 1                                                                                                                                                                                                                                                                                                                                                                                          | Introduction to Data Structures & Algorithm Analysis                                                                                                                                                                                                                                                                                                                        | Assignment      | 9 Sessions |
| Basic concepts: Data, Information, Data Structures; Types of Data Structures (Linear vs Non-linear); Introduction to Algorithms; Characteristics of Algorithms; Time and Space Complexity; Asymptotic Notations: Big-O, Theta ( $\Theta$ ), Omega ( $\Omega$ ); Best, Average, Worst-case analysis                                                                                                |                                                                                                                                                                                                                                                                                                                                                                             |                 |            |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                          | Linear Data Structure                                                                                                                                                                                                                                                                                                                                                       |                 | 9 Sessions |
| Arrays: Representation and operations; Linked Lists: Singly, Doubly, Circular Linked Lists, Insertion, Deletion, Traversal; Stacks: Implementation (Array & Linked List), Applications (Expression evaluation, recursion); Queues: Simple Queue, Circular Queue, Priority Queue, Applications                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                             |                 |            |
| Module 3                                                                                                                                                                                                                                                                                                                                                                                          | Trees and Binary Search Trees                                                                                                                                                                                                                                                                                                                                               | Assignment/Quiz | 9 Sessions |
| Tree Terminology and Properties; Binary Trees: Representation, Traversals (Inorder, Preorder, Postorder); Binary Search Trees (BST): Operations(Insertion, Deletion, Search); Introduction to Heap: Min Heap, Max Heap, Heap Operations                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                             |                 |            |
| Module 4                                                                                                                                                                                                                                                                                                                                                                                          | Graphs and Algorithm Design Techniques                                                                                                                                                                                                                                                                                                                                      | Assignment      | 9 Sessions |
| Graph Representation: Adjacency Matrix, Adjacency List; Graph Traversals: BFS, DFS; Introduction to Algorithm Design Techniques: Divide and Conquer (Binary Search, Merge Sort), Greedy Method (Concept only); Basic Sorting Algorithms: Bubble Sort, Selection Sort, Insertion Sort, Merge Sort, Quick Sort                                                                                      |                                                                                                                                                                                                                                                                                                                                                                             |                 |            |
| Module 5                                                                                                                                                                                                                                                                                                                                                                                          | Advanced Algorithm Analysis                                                                                                                                                                                                                                                                                                                                                 |                 | 9 Sessions |
| Recurrence Relations; Master Theorem (Simple cases); Searching Algorithms: Linear Search, Binary Search; Complexity Comparison of Algorithms; Introduction: Dynamic Programming, Backtracking; Real-world problem solving using DS & Algorithms                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                             |                 |            |
| Targeted Application & Tools that can be used<br>Use of PowerPoint software for lecture slides and use of Modern IDE like VS Code and Eclipse for lab programs to execute.                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                             |                 |            |
| Project work/Assignment:                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                             |                 |            |
| Assignment: Students should complete the module wise assignments before the deadline.                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                             |                 |            |
| Text Book<br><b>T1:</b> Mark Allen Weiss, “Data Structures and Algorithm Analysis in C++”, 4th edition, Pearson Education, 2014.<br><b>T2:</b> Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, “Introduction to Algorithms”, 3rd edition, MIT Press, 2009.<br><b>T3:</b> Reema Thareja, “Data Structures Using C”, 2nd edition, Oxford University Press, 2014.          |                                                                                                                                                                                                                                                                                                                                                                             |                 |            |
| References<br><b>R1:</b> Anany Levitin, “Introduction to the Design and Analysis of Algorithms”, 3rd edition, Pearson Education, 2018.<br><b>R2:</b> Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, “Fundamentals of Data Structures in C”, 2nd edition, Universities Press, 2008.<br><b>R3:</b> Seymour Lipschutz, “Data Structures”, Schaum’s Outline Series, McGraw-Hill Education, 2017. |                                                                                                                                                                                                                                                                                                                                                                             |                 |            |

**R4:** Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, 2003

E-Resources/Web Resources

1. <https://www.geeksforgeeks.org/dsa/dsa-tutorial-learn-data-structures-and-algorithms/>
2. <https://nptel.ac.in/courses/106102064>
3. <https://visualgo.net/en>
4. <https://coursera.org/specializations/algorithms>

|                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |   |   |   |   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|---|---|---|---|
| Course Code<br>CSS2288                                                                                                                                                                                                                                                                                            | Course Title: Data Structures and Analysis of Algorithms Lab<br>Type of Course: Laboratory Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | L-T- P - C | 0 | 0 | 2 | 1 |
| Version No.                                                                                                                                                                                                                                                                                                       | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |            |   |   |   |   |
| Course Pre-requisites                                                                                                                                                                                                                                                                                             | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |            |   |   |   |   |
| Anti-requisites                                                                                                                                                                                                                                                                                                   | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |            |   |   |   |   |
| Course Description                                                                                                                                                                                                                                                                                                | This course is designed to provide hands-on experience in implementing fundamental data structures and analyzing algorithms. It emphasizes practical understanding of arrays, linked lists, stacks, queues, trees, and graphs, along with algorithmic techniques such as searching, sorting, recursion, and graph algorithms. The course also focuses on evaluating the efficiency of algorithms through time and space complexity analysis. Students will develop problem-solving skills by designing, implementing, and analyzing algorithms for real-world applications.                                              |            |   |   |   |   |
| Course Objective                                                                                                                                                                                                                                                                                                  | To develop programming and problem-solving skills by enabling students to implement various data structures, appropriate sorting and searching techniques, analyze their performance through experimentation, and apply structured approaches to solve computational problems effectively.                                                                                                                                                                                                                                                                                                                               |            |   |   |   |   |
| Course Outcomes                                                                                                                                                                                                                                                                                                   | On successful completion of this course, students will be able to:<br><b>CO1:</b> Explain the working principles of fundamental data structures[L2-Understand] and algorithms.<br><b>CO2:</b> Implement basic data structures such as arrays, stacks, queues,[L3-Apply] and linked lists.<br><b>CO3:</b> Apply appropriate sorting and searching techniques for given[L3-Apply] problem statements.<br><b>CO4:</b> Analyze the performance of algorithms using time and space[L4-Analyze] complexity.<br><b>CO5:</b> Design and implement solutions using trees and graph[L4-Analyze] algorithms for practical problems. |            |   |   |   |   |
| Course Content:                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |   |   |   |   |
| <b>List of Laboratory Tasks:</b><br><b>Experiment No. 1:</b><br>Lab Sheet 1: Introduction to Lab Environment, C/C++ Basics Review;<br>Lab Sheet 2: Implementation of Arrays (Insertion, Deletion, Traversal)<br><br><b>Experiment No. 2:</b><br>Lab Sheet 1: Searching Techniques (Linear Search, Binary Search); |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |   |   |   |   |

Lab Sheet 2: Analysis of Searching Algorithms (Time Complexity Comparison)

**Experiment No. 3:**

Lab Sheet 1: Sorting Techniques I (Bubble Sort, Selection Sort);

Lab Sheet 2: Sorting Techniques II (Insertion Sort)

**Experiment No. 4:**

Lab Sheet 1: Advanced Sorting (Merge Sort);

Lab Sheet 2: Quick Sort Implementation and Performance Analysis

**Experiment No. 5:**

Lab Sheet 1: Stack Implementation using Arrays;

Lab Sheet 2: Stack Implementation using Linked Lists

**Experiment No. 6:**

Lab Sheet 1: Applications of Stack (Infix to Postfix Conversion);

Lab Sheet 2: Evaluation of Postfix Expressions

**Experiment No. 7:**

Lab Sheet 1: Queue Implementation using Arrays;

Lab Sheet 2: Circular Queue Implementation

**Experiment No. 8:**

Lab Sheet 1: Priority Queue Implementation;

Lab Sheet 2: Applications of Queue (Simulation Problems)

**Experiment No. 9:**

Lab Sheet 1: Singly Linked List Operations;

Lab Sheet 2: Doubly Linked List Operations

**Experiment No. 10:**

Lab Sheet 1: Circular Linked List Operations;

Lab Sheet 2: Polynomial Manipulation using Linked Lists

**Experiment No. 11:**

Lab Sheet 1: Recursion (Factorial, Fibonacci);

Lab Sheet 2: Recursive Problem Solving (Tower of Hanoi)

**Experiment No. 12:**

Lab Sheet 1: Binary Tree Traversals (Inorder, Preorder, Postorder);

Lab Sheet 2: Binary Search Tree Operations (Insertion, Deletion)

**Experiment No. 13:**

Lab Sheet 1: AVL Trees (Balancing and Rotations);

Lab Sheet 2: Heap Implementation (Min Heap, Max Heap)

**Experiment No. 14:**

Lab Sheet 1: Graph Representation (Adjacency Matrix & List);

Lab Sheet 2: Graph Traversals (DFS, BFS)

**Experiment No. 15:**

Lab Sheet 1: Shortest Path Algorithms (Dijkstra's Algorithm);

Lab Sheet 2: Minimum Spanning Tree (Prim's / Kruskal's Algorithm)

Targeted Application & Tools that can be used

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Use of PowerPoint software for lecture slides and use of Modern IDE like VS Code and Eclipse for lab programs to execute.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Project work/Assignment:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Assignment: Students should complete the lab programs by end of each practical session and module wise assignments before the deadline.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Text Book                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>T1:</b> Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education, 2002.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>T2:</b> Anany Levitin, "Introduction to the Design and Analysis of Algorithms", 3rd Edition, Pearson Education, 2018.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| E-Resources/Web Resources                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <ol style="list-style-type: none"> <li>1. <a href="https://www.geeksforgeeks.org/">https://www.geeksforgeeks.org/</a></li> <li>2. <a href="https://www.programiz.com/dsa">https://www.programiz.com/dsa</a></li> <li>3. <a href="https://visualgo.net/en">https://visualgo.net/en</a></li> <li>4. <a href="https://www.coursera.org/specializations/data-structures-algorithms-tsinghua">https://www.coursera.org/specializations/data-structures-algorithms-tsinghua</a></li> <li>5. <a href="https://ocw.mit.edu/courses/6-851-advanced-data-structures-spring-2012/">https://ocw.mit.edu/courses/6-851-advanced-data-structures-spring-2012/</a></li> </ol> |

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| Course Code:<br>CSD1712                                                                                          | Course Name: Statistical Foundations for Data Science<br>Type of Course: Theory Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | L- T-P- C   | 3-0-0-3     |
| Version No.                                                                                                      | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |             |
| Course Pre-requisites                                                                                            | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |             |
| Co-requisites                                                                                                    | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |             |
| Anti-requisites                                                                                                  | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |             |
| Course Description                                                                                               | This course provides an in-depth introduction to statistics and machine learning theory, methods, and algorithms for data science. Topics include multiple regression, kernel learning, sparse regression, generalized linear models, supervised and unsupervised learning, deep learning, covariance learning, factor models, principal component analysis, and more. The course emphasizes the applicability and limitations of these methods using mathematical statistics and real-world data sets.                                                                                         |             |             |
| Course Objective                                                                                                 | The objective of the course is to familiarize the learners with the concepts of Statistical Foundations for Data Science and attain Employability through Participative Learning techniques                                                                                                                                                                                                                                                                                                                                                                                                     |             |             |
| Course Outcomes                                                                                                  | On successful completion of the course the students shall be able to:<br>1.Understand the rise and significance of Big Data in various fields such as Biological Sciences, Health Sciences, Computer and Information Sciences, Economics and Finance, Business and Program Evaluation, Earth Sciences, and Astronomy.<br>2.Develop a strong foundation in multiple linear regression and the Gauss-Markov theorem.<br>3.Apply linear regression with random design and partial linear regression.<br>4.Apply the power method and learn about factor models and structured covariance learning. |             |             |
| Course Content:                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |             |             |
| Module 1                                                                                                         | Assignment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Programming | 10 Sessions |
| Topics:<br>Introduction to bigdata, Rise of Big Data and Dimensionality in -Biological Sciences ,Health Sciences |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |             |             |

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| , Computer and Information Sciences , Economics and Finance, Business and Program Evaluation, Earth Sciences and Astronomy - Impact of Big Data - Impact of Dimensionality , Computation of Noise Accumulation , Spurious Correlation , Statistical theory - Aim of High-dimensional Statistical Learning.                                                                                                                                                                                                                                                                                                                                                                              |            |                                                                                                                        |             |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Assignment | Programming                                                                                                            | 12 Sessions |
| Topics:<br>Multiple Linear Regression, The Gauss-Markov Theorem , Statistical Tests - Weighted Least-Squares , Box-Cox Transformation , Model Building and Basis Expansions, Polynomial Regression - Spline Regression , Multiple Covariates , Ridge Regression - Bias-Variance Tradeoff - Penalized Least Squares - Bayesian Interpretation - Ridge Regression Solution Path - Kernel Ridge Regression , Exponential family 231 5.1.2 Elements of generalized linear models , Maximum likelihood , Computing MLE: Iteratively reweighed least squares , Deviance and Analysis of Deviance, Regularization parameters, Refitted Cross-validation, Extensions to Nonparametric Modeling. |            |                                                                                                                        |             |
| Module 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Assignment | Programming                                                                                                            | 14 Sessions |
| Topics:<br>Inference in linear regression - Debias of regularized regression estimators , Choices of weights , Inference for the noise level , Inference in generalized linear models , Desparsified Lasso , Decorrelated score estimator - Test of linear hypotheses , Numerical comparison - Asymptotic efficiency 345 7.3.1 Statistical efficiency and Fisher information, Linear regression with random design , Partial linear regression , Gaussian graphical models - Inference via penalized least squares , Sample size in regression and graphical models , General solutions , Local semi-LD decomposition , Data swap , Gradient approximation                              |            |                                                                                                                        |             |
| Module 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Assignment | Programming                                                                                                            | 9 Sessions  |
| Topics:<br>Principal Component Analysis -Introduction to PCA , Power Method , Factor Models and Structured Covariance Learning , Factor model and high-dimensional PCA-Cluster Analysis - K-means clustering , Hierarchical clustering , Model-based clustering , Spectral clustering , Data-driven choices of the number of clusters , Variable Selection in Clustering , Sparse K-means clustering , Sparse model-based clustering , Sparse Mixture of Experts Model, Correlation Screening, Generalized and Rank Correlation Screening, Nonparametric Screening, Sure Screening and False Selection                                                                                  |            |                                                                                                                        |             |
| Targeted Applications & Tools:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |                                                                                                                        |             |
| Python (NumPy, pandas)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |            | Core programming language and libraries used for data manipulation, cleaning, and preprocessing throughout the course. |             |
| Torch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |            |                                                                                                                        |             |
| Google Colaboratory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                                                                                                                        |             |
| Spider                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |            |                                                                                                                        |             |
| Jupyter Notebook                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |            |                                                                                                                        |             |
| Text Book                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |            |                                                                                                                        |             |
| T1. Fan, J., Li, R., Zhang, C.-H., and Zou, H. (2020). Statistical Foundations of Data Science. CRC Press.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                                                                                                                        |             |
| T2. Wainwright, M. J. (2019). High-dimensional statistics: A non-asymptotic viewpoint. Cambridge University Press.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |            |                                                                                                                        |             |
| References                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                                                                                                                        |             |
| R1: James, G., Witten, D., Hastie, T.J., Tibshirani, R. and Friedman, J. (2013). An Introduction to Statistical Learning with Applications in R . Springer, New York.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |            |                                                                                                                        |             |
| R2. Hastie, T.J., Tibshirani, R. and Friedman, J. (2009). The elements of Statistical Learning: Data Mining, Inference, and Prediction (2nd ed). Springer, New York.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            |                                                                                                                        |             |
| R3. Buehlmann, P. and van de Geer, S. (2011). Statistics for High-Dimensional Data: Methods, Theory and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |            |                                                                                                                        |             |

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| Applications. Springer, New York.                                                                                                                                                                                                                                                                                                                  |
| E-Resources/Web Resources <ol style="list-style-type: none"> <li>1. <a href="https://www.youtube.com/playlist?list=PLOU2XLYxmsIK9qQfztXeybpHvru-TrqAP">https://www.youtube.com/playlist?list=PLOU2XLYxmsIK9qQfztXeybpHvru-TrqAP</a></li> <li>2. <a href="https://presiuniv.knimbus.com/user#/">https://presiuniv.knimbus.com/user#/</a></li> </ol> |

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| Course Code:<br>CSD1713                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Course Name: Statistical Foundations for<br>Data Science<br>Type of Course: Laboratory Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | L- T-P- C | 0-0-2-1 |
| Version No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |         |
| Course Pre-requisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |         |
| Co-requisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | CSD1712                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |         |
| Anti-requisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |         |
| Course Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | This course provides an in-depth introduction to statistics and machine learning theory, methods, and algorithms for data science. Topics include multiple regression, kernel learning, sparse regression, generalized linear models, supervised and unsupervised learning, deep learning, covariance learning, factor models, principal component analysis, and more. The course emphasizes the applicability and limitations of these methods using mathematical statistics and real-world data sets.                                                                                                                                                                                     |           |         |
| Course Objective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | The objective of the course is to familiarize the learners with the concepts of Statistical Foundations for Data Science and attain Employability through Participative Learning techniques.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |           |         |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>On successful completion of the course the students shall be able to:</b><br>CO1: Understand the rise and significance of Big Data in[Level 2 – Understand] various fields such as Biological Sciences, Health Sciences, Computer and Information Sciences, Economics and Finance, Business and Program Evaluation, Earth Sciences, and Astronomy.<br>CO2: Develop a strong foundation in multiple linear[Level 3 – Apply] regression and the Gauss-Markov theorem.<br>CO3: Apply linear regression with random design and partial[Level 3 – Apply] linear regression.<br>CO4: Apply the power method and learn about factor[Level 3 – Apply] models and structured covariance learning. |           |         |
| Course Content:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |         |
| <b>List of Laboratory Tasks:</b><br>Experiment 1: Use big data to predict patient outcomes.<br>Experiment 2: Predict stock market trends using big data.<br>Experiment 3: Segment customers based on purchasing behavior.<br>Experiment 4: Apply statistical learning techniques to high-dimensional data.<br>Experiment 5: The Gauss-Markov Theorem<br>Experiment 6: Statistical Tests - Weighted Least-Squares<br>Experiment 7: Box-Cox Transformation<br><br>Experiment 8: Ridge Regression - Bias-Variance Tradeoff<br>Experiment 9: Ridge Regression Solution Path - Kernel Ridge Regression<br>Experiment 10: Debias of Regularized Regression Estimators<br>Experiment 11: Inference in Generalized Linear Models (GLMs)<br>Experiment 12: Partial Linear regression |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |         |

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| <p>Experiment 13: Power Method: To implement the Power Method for finding the largest eigenvalue and corresponding eigenvector.</p> <p>Experiment 14: Factor model and high-dimensional PCA</p> <p>Experiment 15: Hierarchical clustering</p>                                                                                                                                                                                                                                                                                                    |                                                                                                                                                       |
| Targeted Applications & Tools:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                       |
| Torch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | An open-source deep learning framework used for building, training, and deploying machine learning and neural network models.                         |
| Google Colaboratory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | A cloud-based Python development environment that allows users to write and execute machine learning and data science programs through a web browser. |
| Spider                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | An open-source scientific Python development environment (IDE) used for data analysis, visualization, and machine learning applications.              |
| Jupyter Notebook                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | An interactive web-based platform used for writing and executing code, data visualization, and documenting data science experiments.                  |
| <p>Text Book</p> <p><b>T1:</b> Fan, J., Li, R., Zhang, C.-H., and Zou, H. (2020). Statistical Foundations of Data Science. CRC Press.</p> <p><b>T2:</b> Wainwright, M. J. (2019). High-dimensional statistics: A non-asymptotic viewpoint. Cambridge University Press</p>                                                                                                                                                                                                                                                                        |                                                                                                                                                       |
| <p>References</p> <p><b>R1:</b> James, G., Witten, D., Hastie, T.J., Tibshirani, R. and Friedman, J. (2013). An Introduction to Statistical Learning with Applications in R. Springer, New York.</p> <p><b>R2:</b> Hastie, T.J., Tibshirani, R. and Friedman, J. (2009). The elements of Statistical Learning: Data Mining, Inference, and Prediction (2nd ed). Springer, New York..</p> <p><b>R3:</b> Buehlmann, P. and van de Geer, S. (2011). Statistics for High-Dimensional Data: Methods, Theory and Applications. Springer, New York.</p> |                                                                                                                                                       |
| <p>E-Resources/Web Resources</p> <ol style="list-style-type: none"> <li><a href="https://www.youtube.com/playlist?list=PLOU2XLYxmsIK9qQfztXeybpHvru-TrqAP">https://www.youtube.com/playlist?list=PLOU2XLYxmsIK9qQfztXeybpHvru-TrqAP</a> MITopencourseware:</li> <li><a href="https://presiuniv.knimbus.com/user#/">https://presiuniv.knimbus.com/user#/</a></li> </ol>                                                                                                                                                                           |                                                                                                                                                       |

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| Course Code:<br>CSS2255 | Course Name: Object Oriented<br>Programming Using Java<br>Type of Course: Theory Course                                                                                                                                                                                                                                                                                                   | L- T-P- C | 3-0-0-3 |
| Version No.             | 2.0                                                                                                                                                                                                                                                                                                                                                                                       |           |         |
| Course Pre-requisites   | NIL                                                                                                                                                                                                                                                                                                                                                                                       |           |         |
| Co-requisites           | CAI2256                                                                                                                                                                                                                                                                                                                                                                                   |           |         |
| Anti-requisites         | NIL                                                                                                                                                                                                                                                                                                                                                                                       |           |         |
| Course Description      | This course introduces the core concepts of object-oriented programming. This course has theory and lab component which emphasizes on understanding the implementation and application of object-oriented programming paradigm. It helps the student to build real time secure applications by applying these concepts and also for effective problem solving. The students interpret and |           |         |

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|                                                                                                                                                                                                                                                                                                                                                                                                                           | understand the need for object oriented programming to build applications.                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                         |             |
| Course Objective                                                                                                                                                                                                                                                                                                                                                                                                          | The objective of the course is to familiarize the learners with the concepts of Problem-Solving using JAVA and attain SKILL DEVELOPMENT through EXPERIENTIAL LEARNING techniques                                                                                                                                                                                                                                                                                                                                                                 |                         |             |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                           | <b>On successful completion of the course the students shall be able to:</b><br><br><b>C01:</b> Describe the basic programming concepts [Level 2 - Understand]<br><b>C02:</b> Apply the concept of classes, objects and methods to solve problems [Level 3 - Apply]<br><b>C03:</b> Apply the concept of arrays and strings. [Level 3 - Apply]<br><b>C04:</b> Implement inheritance and polymorphism building secure applications [Level 3 - Apply]<br><b>C05:</b> Apply the concepts of interface and error handling mechanism [Level 3 - Apply] |                         |             |
| Course Content:                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                         |             |
| Module 1                                                                                                                                                                                                                                                                                                                                                                                                                  | Basic Concepts of Programming and Java                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Assessment: Assignment  | 9 Sessions  |
| Topics:<br>Introduction to Principles of Programming: Process of Problem Solving, Java program structure, Download Eclipse IDE to run Java programs, Sample program, Data types, Identifiers, Variables, Constants in java, Operators, Assignments and Expression, Basic Input/ Output functions, Control Statements: Branching and Looping.                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                         |             |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                                                  | Classes, objects, methods and Constructors                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Assessment : Assignment | 10 Sessions |
| Topics:<br>Classes, Objects and Methods: Introduction to object Oriented Principles, defining a class, adding data members and methods to the class, access specifiers, instantiating objects, reference variable, accessing class members and methods Static Polymorphism: Method overloading, constructors, constructor overloading, this keyword, static keyword, Nested classes, Accessing members in nested classes. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                         |             |
| Module 3                                                                                                                                                                                                                                                                                                                                                                                                                  | Arrays, String and String buffer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Assessment : Assignment | 8 Sessions  |
| Topics:<br>Topics: Arrays: Defining an Array, Initializing & Accessing Array, Multi -Dimensional Array, Array of objects. String: Creation & Operation. String builder class, methods in String Buffer.                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                         |             |
| Module 4                                                                                                                                                                                                                                                                                                                                                                                                                  | Inheritance and Polymorphism                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Assessment : Assignment | 10 Sessions |
| Topics:<br>Inheritance: Defining a subclass, Types of Inheritance, super keyword. Dynamic Polymorphism: Method overriding. Final keyword: with data members, with member functions and with class. Abstract keyword: with data members, with member functions and with class, Exception handling.                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                         |             |
| Module 5                                                                                                                                                                                                                                                                                                                                                                                                                  | Input & Output Operation in Java                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Assessment : Assignment | 8 Sessions  |
| Topics:<br>Input/output Operation in Java(java.io Package), Streams and the new I/O Capabilities, Understanding Streams, working with File Object, File I/O Basics, Reading and Writing to Files, Buffer and Buffer Management, Read/Write Operations with File Channel, Serializing Objects, Observer and Observable Interfaces.                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                         |             |

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| Targeted Applications & Tools:                                                                                                                                                                                                                                                                                                                     |                                                                                                 |
| JDK (Java Development Kit)                                                                                                                                                                                                                                                                                                                         | A software development kit used to develop, compile, and run Java applications.                 |
| Eclipse IDE                                                                                                                                                                                                                                                                                                                                        | An integrated development environment used for coding, debugging, and testing Java programs.    |
| NetBeans IDE                                                                                                                                                                                                                                                                                                                                       | An open-source IDE that supports Java application development with built-in tools and libraries |
| IntelliJ IDEA                                                                                                                                                                                                                                                                                                                                      | A professional IDE that provides advanced features for efficient Java development               |
| BlueJ                                                                                                                                                                                                                                                                                                                                              | An educational Java development environment designed for learning object-oriented programming   |
| Skill-Building Activities through Experiential Learning:                                                                                                                                                                                                                                                                                           |                                                                                                 |
| <ul style="list-style-type: none"> <li>Solving programming problems using object-oriented programming concepts.</li> <li>Developing algorithms and flowcharts for real-world applications.</li> <li>Case study analysis of Java-based software systems.</li> <li>Debugging and code review exercises to improve problem-solving skills.</li> </ul> |                                                                                                 |
| Text Book                                                                                                                                                                                                                                                                                                                                          |                                                                                                 |
| <b>T1:</b> Herbert Schildt, "The Complete Reference Java 2", Tata McGraw Hill Education, 11th Edition, 2019.                                                                                                                                                                                                                                       |                                                                                                 |
| <b>T2:</b> Head First Java, Kathy Sierra and Bert Bates, Head First Java, O'Reilly Media                                                                                                                                                                                                                                                           |                                                                                                 |
| References                                                                                                                                                                                                                                                                                                                                         |                                                                                                 |
| <b>R1:</b> Cay S Horstmann and Cary Gornell, "CORE JAVA volume I-Fundamentals", Tenth Edition, Pearson 2015..                                                                                                                                                                                                                                      |                                                                                                 |
| <b>R2:</b> James W. Cooper, "Java TM Design Patterns – A Tutorial", Addison-Wesley Publishers. 4th Edition, 2000..                                                                                                                                                                                                                                 |                                                                                                 |
| <b>R3:</b> E. Balagurusamy, "Programming with Java", Tata McGraw Hill Education, 6th Edition, 2019.                                                                                                                                                                                                                                                |                                                                                                 |
| E-Resources/Web Resources                                                                                                                                                                                                                                                                                                                          |                                                                                                 |
| 1. <a href="http://rmi.yaht.net/bookz/core.java/9780134177373-Vol-1.pdf">http://rmi.yaht.net/bookz/core.java/9780134177373-Vol-1.pdf</a><br>2. <a href="https://openFullText.html?DP=https://docs.oracle.com/javase/tutorial/">https://openFullText.html?DP=https://docs.oracle.com/javase/tutorial/</a>                                           |                                                                                                 |

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| Course Code: CSS2256  | Course Title: Object Oriented Programming Using Java Lab<br>Type of Course: Laboratory Course (PCC)                                                                                                                                                                                                                                                                                                                                                                  | L-T- P-C | 0 | 0 | 2 | 1 |
| Version No.           | 2.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |          |   |   |   |   |
| Course Pre-requisites | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |          |   |   |   |   |
| Anti-requisites       | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |          |   |   |   |   |
| Course Description    | This course introduces the core concepts of object-oriented programming. This course has theory and lab component which emphasizes on understanding the implementation and application of object-oriented programming paradigm. It helps the student to build real time secure applications by applying these concepts and also for effective problem solving. The students interpret and understand the need for object oriented programming to build applications. |          |   |   |   |   |
| Course Objective      | The objective of the course is to familiarize the learners with the concepts of Problem-Solving using JAVA and attain SKILL DEVELOPMENT through EXPERIENTIAL LEARNING techniques                                                                                                                                                                                                                                                                                     |          |   |   |   |   |
| Course Outcomes       | On successful completion of the course, students shall be able to:<br>CO1: Demonstrate fundamental programming concepts. [Apply]<br>CO2: Apply the concepts of classes, objects, and methods to solve problems. [Apply]                                                                                                                                                                                                                                              |          |   |   |   |   |

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| <b>Course Content:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>30 Sessions</b>                                                                                                                                                                                                                                 |
| <b>List of Laboratory Tasks:</b><br><b>Week 1:</b><br><b>Lab Sheet 1: Java Program Structure &amp; Basic I/O</b><br><b>Level 1:</b><br>Write a Java program to display "Hello, Java".<br>Demonstrate use of variables and data types.<br><b>Level 2:</b><br>Write a Java program to take user input (name, age) and display formatted output.<br><b>Week 2:</b><br><b>Lab Sheet 2: Operators and Expressions</b><br><b>Level 1:</b><br>Write a Java program to perform arithmetic operations (+, -, *, /, %).<br><b>Level 2:</b><br>Develop a program to evaluate a complex expression using relational and logical operators.<br><b>Week 3:</b><br><b>Lab Sheet 3: Control Statements – Branching</b><br><b>Level 1:</b><br>Write a Java program to check whether a number is even or odd using if-else.<br><b>Level 2:</b><br>Implement a menu-driven calculator using switch-case.<br><b>Week 4:</b><br><b>Lab Sheet 4: Control Statements – Looping</b><br><b>Level 1:</b><br>Write programs using loops:<br>1. Print numbers from 1 to N<br>2. Find factorial of a number<br><b>Level 2:</b><br>Generate Fibonacci series and check whether a number is prime.<br><b>Week 5:</b><br><b>Lab Sheet 5: Classes and Objects</b><br><b>Level 1:</b><br>Create a class Student with data members and display details using object.<br><b>Level 2:</b><br>Create multiple objects and demonstrate accessing members using reference variables.<br><b>Week 6:</b><br><b>Lab Sheet 6: Methods and Access Specifiers</b><br><b>Level 1:</b><br>Write a class with methods to perform addition and subtraction.<br><b>Level 2:</b><br>Demonstrate use of public, private, and protected access specifiers.<br><b>Week 7:</b><br><b>Lab Sheet 7: Constructors and Overloading</b><br><b>Level 1:</b><br>Implement a class with a default constructor and parameterized constructor.<br><b>Level 2:</b><br>Demonstrate constructor overloading and use of this keyword.<br><b>Week 8:</b><br><b>Lab Sheet 8: Static Keyword &amp; Nested Classes</b><br><b>Level 1:</b><br>Write a program demonstrating static variables and static methods. |                                                                                                                                                                                                                                                    |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |
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| <p><b>Level 2:</b><br/>Create a nested class and access its members from the outer class.</p> <p><b>Week 9:</b><br/><b>Lab Sheet 9: Arrays (1D and 2D)</b></p> <p><b>Level 1:</b><br/>Write programs for:</p> <ol style="list-style-type: none"> <li>1. Sum of array elements</li> <li>2. Find largest element</li> </ol> <p><b>Level 2:</b><br/>Perform matrix addition and multiplication using 2D arrays.</p> <p><b>Week 10:</b><br/><b>Lab Sheet 10: Array of Objects</b></p> <p><b>Level 1:</b><br/>Create an array of objects (e.g., Employee class).</p> <p><b>Level 2:</b><br/>Perform operations like sorting objects based on a field.</p> <p><b>Week 11:</b><br/><b>Lab Sheet 11: Strings and StringBuffer</b></p> <p><b>Level 1:</b><br/>Perform basic string operations: Length, concatenation, comparison</p> <p><b>Level 2:</b><br/>Demonstrate mutable operations using StringBuffer and StringBuilder.</p> <p><b>Week 12:</b><br/><b>Lab Sheet 12: Inheritance</b></p> <p><b>Level 1:</b><br/>Create a base class and derived class using single inheritance.</p> <p><b>Level 2:</b><br/>Implement multilevel inheritance and demonstrate use of super keyword.</p> <p><b>Week 13:</b><br/><b>Lab Sheet 13: Polymorphism &amp; Abstract Classes</b></p> <p><b>Level 1:</b><br/>Demonstrate method overriding (runtime polymorphism).</p> <p><b>Level 2:</b><br/>Create an abstract class and implement its methods in a subclass.</p> <p><b>Week 14:</b><br/><b>Lab Sheet 14: Exception Handling</b></p> <p><b>Level 1:</b><br/>Handle exceptions using try-catch-finally.</p> <p><b>Level 2:</b><br/>Create custom exceptions and demonstrate multiple catch blocks.</p> <p><b>Week 15:</b><br/><b>Lab Sheet 15: File Handling and Serialization</b></p> <p><b>Level 1:</b><br/>Write a Java program to Create a file &amp; Write and read data using File I/O</p> <p><b>Level 2:</b><br/>Implement object serialization and deserialization.<br/>Use File streams and buffered streams for efficient I/O.</p> |  |
| <p><b>Targeted Application &amp; Tools that can be used :</b> JDK /Eclipse IDE/Visual Studio Code / net Beans IDE.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |
| <p><b>Text Book</b></p> <ol style="list-style-type: none"> <li>1. Herbert Schildt, "The Complete Reference Java 2", Tata McGraw Hill Education, 11th Edition,2019.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |

**References**

1. Cay S Horstmann and Cary Gornell, "CORE JAVA volume I-Fundamentals", Tenth Edition, Pearson 2015.
2. James W. Cooper, "Java TM Design Patterns – A Tutorial", Addison-Wesley Publishers.4<sup>th</sup> Edition, 2000.
3. E. Balagurusamy, "Programming with Java", Tata McGraw Hill Education, 6<sup>th</sup> Edition, 2019.

**E book link R1:** <http://rmi.yaht.net/bookz/core.java/9780134177373-Vol-1.pdf>

**E book link R2:** [java\(tm\) Design Patterns: A Tutorial\( \[PDF\] \[7qmsenjl97t0\] \(vdoc.pub\)](#)

**Web resources**

[https://youtube.com/playlist?list=PLu0W\\_9lII9agS67Uits0UnJyrYiXhDS6q](https://youtube.com/playlist?list=PLu0W_9lII9agS67Uits0UnJyrYiXhDS6q)

<https://puniversity.informaticsglobal.com:2229/login.aspx>

**Topics relevant to development of "Skill Development":**

1. Static Polymorphism
2. Method overloading, constructors
3. constructor overloading
4. this keyword
5. static keyword and Inner classes
6. Inheritance and Polymorphism.

This is attained through assessment component mentioned in course handout.

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|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|---------|
| Course Code:<br>CSD2002 | Course Name: Introduction to Data Science<br>Type of Course: Theory Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | L- T-P- C | 3-0-0-3 |
| Version No.             | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |         |
| Course Pre-requisites   | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |         |
| Co-requisites           | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |         |
| Anti-requisites         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |         |
| Course Description      | This course offers a comprehensive introduction to the interdisciplinary field of Data Science. Students will explore the data science lifecycle, beginning with data acquisition and progressing through cleaning, exploratory analysis, visualization, and basic predictive modeling. Emphasis is placed on using Python-based tools (Pandas, NumPy, Matplotlib, Seaborn, Scikit-learn) to perform real-world data tasks. The course fosters critical thinking, statistical reasoning, and data-driven decision-making essential for modern data science roles. |           |         |
| Course Objective        | To introduce students to the fundamentals and workflow of Data Science<br>To impart practical experience with Python tools used in data analysis<br>To develop understanding of data exploration, transformation, and visualization techniques<br>To build foundational knowledge of statistical methods and basic predictive modeling                                                                                                                                                                                                                            |           |         |

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| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | On successful completion of the course the students shall be able to:       |                 |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | CO1: Describe the stages of the data science lifecycle and tools used       |                 |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | CO2: Perform data wrangling, cleaning, and exploratory analysis with Python |                 |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | CO3: Create and interpret data visualizations for effective communication   |                 |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | CO4: Apply basic statistical concepts and develop predictive models         |                 |             |
| Course Content:                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                             |                 |             |
| Module 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Quiz                                                                        | Knowledge based | 10 sessions |
| Topics:<br>Introduction to Data Science: Definitions and Applications, Data Science Lifecycle, Python for Data Science: Syntax, Variables, Data Types, Control Flow, Setting up Environment: Jupyter Notebook, Anaconda, Google Colab, Working with Python Libraries: NumPy and Pandas Basics, Real-world applications of Data Science (case studies from healthcare, finance, and social media)                                                                                     |                                                                             |                 |             |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Assignment                                                                  | Implementation  | 12 sessions |
| Topi DataFrames and Series in Pandas , Data Cleaning: Missing Values, Duplicates, Data Type Conversion, Data Transformation: Sorting, Filtering, Merging, Grouping,Feature Engineering Basics, Exploratory Data Analysis (EDA): Descriptive Statistics, Distributions, Outlier Detection, Hands-on: Analyzing a public dataset (e.g., Titanic, Iris)                                                                                                                                 |                                                                             |                 |             |
| Module 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Term paper/Assignment                                                       | Implementation  | 11 sessions |
| Topics:<br>Introduction to Data Visualization: Importance & Principles,Visualization with Matplotlib and Seaborn Line Charts, Bar Charts, Histograms, Boxplots, Pairplots, Heatmaps, KDE plots, and advanced visualizations, Creating Dashboards using Plotly or Streamlit (Intro), Data Storytelling: How to Present Data Insights Effectively , Project: Create an interactive EDA dashboard                                                                                       |                                                                             |                 |             |
| Module 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Term paper/Assignment                                                       | Implementation  | 12 sessions |
| Topics:<br>Descriptive Statistics: Mean, Median, Mode, Variance, Standard Deviation, Probability Basics and Distributions , Hypothesis Testing: t-Test, p-value, Confidence Intervals, Correlation and Causation, Introduction to Regression:<br>•Simple and Multiple Linear Regression<br>•Classification Overview: Logistic Regression<br>Introduction to Model Evaluation: Accuracy, Confusion Matrix, Precision, Recall, Case Study: Predictive modeling on a real dataset       |                                                                             |                 |             |
| Text Book<br>T1: Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Jupyter ,Author: Wes McKinney,Publisher: O'Reilly Media, Edition: 3rd Edition, 2023                                                                                                                                                                                                                                                                                                                |                                                                             |                 |             |
| References<br>R1: Practical Statistics for Data Scientists: 50+ Essential Concepts,Authors: Peter Bruce, Andrew Bruce, Peter Gedeck, Publisher: O'Reilly Media, 2nd Edition (2021).<br>R2: Title: Doing Data Science, Authors: Cathy O'Neil, Rachel Schutt, Publisher: O'Reilly Media.<br>R3: Title: An Introduction to Statistical Learning with Applications in R,Authors: Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Publisher: Springer, 2nd Edition (2021) |                                                                             |                 |             |

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| E-Resources/Web Resources                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <ol style="list-style-type: none"> <li>1. <a href="https://www.ibm.com/topics/data-science">https://www.ibm.com/topics/data-science</a></li> <li>2. <a href="https://www.coursera.org/learn/what-is-datascience">https://www.coursera.org/learn/what-is-datascience</a></li> <li>3. <a href="https://www.kaggle.com/learn">https://www.kaggle.com/learn</a></li> <li>4. <a href="https://www.datacamp.com/courses/introduction-to-data-science-in-python">https://www.datacamp.com/courses/introduction-to-data-science-in-python</a></li> </ol> |

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| CourseCode:<br>APT4002                                                                                                                                                               | CourseTitle:IntroductiontoAptitude<br>(Audited)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | L-T- P- C  | 0-0-2-0                                         |
| Version No.                                                                                                                                                                          | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            |                                                 |
| CoursePre-requisites                                                                                                                                                                 | Students should know the basic Mathematic & aptitude along with understanding of English                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |            |                                                 |
| Anti-requisites                                                                                                                                                                      | Nil                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            |                                                 |
| Course Description                                                                                                                                                                   | Theobjectiveofthiscourseistopreparethetraineestotacklethequestionson various topics and various difficulty levels based on Quantitative Ability, and Logical Reasoning asked during the placement drives. There will be sufficient focus on building the fundamentals of all the topics, as well as on solving the higherorderthinkingquestions.Thefocusofthiscourseistoteachthestudents tonotonlygettothe correct answers,butto get there fasterthanever before, which will improve their employability factor.                                                       |            |                                                 |
| Course Objective                                                                                                                                                                     | The objective of the course is to familiarize the learners with the concepts ofAptitude and attain Skill Development through Problem Solving techniques.                                                                                                                                                                                                                                                                                                                                                                                                               |            |                                                 |
| Course Outcomes                                                                                                                                                                      | Onsuccessfulcompletionofthecoursethestudentsshallbeableto:<br><b>CO1:</b> Recall all the basic mathematical concepts they learnt in[Level 1 – Remember] high school.<br><b>CO2:</b> Identify the principle concept needed in a question. [Level 2 – Understand]<br><b>CO3:</b> Solve the quantitative and logical ability questions with[Level 3 – Apply] the appropriate concept.<br><b>CO4:</b> Analyze the data given in complex problems. [Level 4 – Analyze]<br><b>CO5:</b> Rearrange the information to simplify the question give[Level 4 – Analyze] me levels. |            |                                                 |
| CourseContent:                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |            |                                                 |
| Module1                                                                                                                                                                              | Quantitative Ability                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Assignment | Bloom’sLevel: Application<br><br><b>12Hours</b> |
| Topics:<br>IntroductiontoAptitude,workingofTables,Squares,Cubes                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |            |                                                 |
| Module2                                                                                                                                                                              | Logical Reasoning                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Assignment | Bloom’sLevel: Application<br><br><b>18Hours</b> |
| Topics:<br>Linear&CircularArrangementPuzzle,Coding&Decoding,BloodRelations,Directions,Orderingand Ranking, Clocks and Calendars,Number Series, Wrong number series, Visual Reasoning |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |            |                                                 |
| TargetedApplication&Toolsthatcanbeused:<br>Applicationarea:PlacementactivitiesandCompetitiveexaminations. Tools: LMS                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |            |                                                 |

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| <b>TextBook</b>                                                                                                                                                                                                       |  |
| 1. Quantitative Aptitude by RS Aggarwal<br>2. Verbal & Non-Verbal Reasoning by RS Aggarwal                                                                                                                            |  |
| <b>References</b>                                                                                                                                                                                                     |  |
| 1. <a href="http://www.indiabix.com">www.indiabix.com</a><br>2. <a href="http://www.youtube.com/c/TheAptitudeGuy/videos">www.youtube.com/c/TheAptitudeGuy/videos</a>                                                  |  |
| <b>Topics relevant to Skill development:</b> Quantitative and reasoning aptitude for Skill Development through Problem Solving Techniques. This is attained through assessment component mentioned in course handout. |  |

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| Course Code:<br>CHE7601                                                                                                                                                                                                                                   | Course Name: Environmental Studies<br>Type of Course:MOOC course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | L- T-P- C      | 1-0-0-0 |
| Version No.                                                                                                                                                                                                                                               | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                |         |
| NCrF Level-                                                                                                                                                                                                                                               | 5.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                |         |
| Course Pre-requisites                                                                                                                                                                                                                                     | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                |         |
| Co-requisites                                                                                                                                                                                                                                             | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                |         |
| Anti-requisites                                                                                                                                                                                                                                           | CSEXxxx                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                |         |
| Course Description                                                                                                                                                                                                                                        | This course is designed to improve the learners' SKILL DEVELOPMENT by using PATICIPATIVE LEARNING techniques. This course aims to familiarize students with fundamental environmental concepts and their relevance to business operations, preparing them to address forthcoming sustainability challenges. It is designed to equip students with the knowledge and skills needed to make decisions that account for environmental consequences, fostering environmentally sensitive and responsible future managers.<br>This course is designed to cater to Environment and Sustainability |                |         |
| Course Objective                                                                                                                                                                                                                                          | The objective of the course is 'SKILL DEVELOPMENT' of the student by using 'PARTICIPATIVE LEARNING' techniques                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                |         |
| Course Outcomes                                                                                                                                                                                                                                           | On successful completion of the course the students shall be able to:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                |         |
|                                                                                                                                                                                                                                                           | CO1: Describe the issues related to natural resources, ecosystems and biodiversity                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | L1- Remember   |         |
|                                                                                                                                                                                                                                                           | CO2: Identify environmental hazards affecting air, water and soil quality                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | L2- Understand |         |
|                                                                                                                                                                                                                                                           | CO3:Recognize the importance of healthy environment and finding the sustainable methods to protect the environment                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | L3 - Apply     |         |
|                                                                                                                                                                                                                                                           | CO4: Convert skills to address immediate environmental concerns through changes in environmental processes, policies, and decisions                                                                                                                                                                                                                                                                                                                                                                                                                                                         | L4 - Analyze   |         |
| Course Content:                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                |         |
| Module 1                                                                                                                                                                                                                                                  | Understanding Environment, Natural Resources, and Sustainability                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                |         |
| Topics:<br>Classification of natural resources, issues related to Population growth and their overutilization, and strategies for their conservation. Water, air, soil, mineral, energy and food source. Effect of human activities on natural resources. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                |         |

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| Concept of sustainability- Sustainable Development Goals (SDGs)- targets and indicators, challenges and strategies for SDGs; Sustainable practices in managing resources, including deforestation, water conservation, Desalination – types, energy security, and food security issues, Life Cycle thinking and Circular Economy.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                        |  |  |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Ecosystems, Biodiversity, and Sustainable Practices                    |  |  |
| <p>Topics:</p> <p>Ecosystems and ecosystem services: Various natural ecosystems, Major ecosystem types in India and their basic characteristics; forests, wetlands, grasslands, agriculture, coastal and marine; Ecosystem services- classification and their significance.</p> <p>The importance of biodiversity, Types of biodiversity, Biodiversity and Climate Change, the threats it faces, hotspots, and the methods used for its conservation. Strategies for in situ and ex situ conservation, mega diverse nation.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                        |  |  |
| Module 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Environmental Pollution, Waste Management, and Sustainable Development |  |  |
| <p>Topics:</p> <p>Types of pollution- Chemical, - Biological, Biomedical, noise, air, water, soil, thermal, radioactive and marine pollution, and their impacts on society. Urbanization and Urban environmental problems; effects, and mitigation.</p> <p>Causes of pollution, such as global climate change, ozone layer depletion, the greenhouse effect, and acid rain, with a particular focus on pollution episodes in India. Importance of adopting cleaner technologies; Solid waste management;</p> <p>Sustainable Materials and Technologies: Biodegradable and compostable materials, Recycled and reclaimed materials (E-waste management), Sustainable manufacturing processes.</p>                                                                                                                                                                                                                                                                                                                                                                         |                                                                        |  |  |
| Module 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Social Issues, Legislation, and Practical Applications                 |  |  |
| <p>Topics:</p> <p>Overview of key environmental legislation and the judiciary's role in environmental protection, including the Water (Prevention and Control of Pollution) Act of 1974, the Environment (Protection) Act of 1986, and the Air (Prevention and Control of Pollution) Act of 1981. Hazardous waste Rule 1989, Biomedical Waste handling 1998, Fly Ash Rule 1999, Municipal Solid Waste Rule 2000, Battery Rules 2001, E- Waste Rules 2011, Plastic waste management Rules 2016, Construction Demolition waste Rules 2016 National Biodiversity Action Plan (NBAP)</p> <p>Major International Environmental Agreements: Convention on Biological Diversity (CBD), The Biological Diversity (Amendment) Act, 2023, United Nations Framework Convention on Climate Change (UNFCCC); Kyoto Protocol; Paris Agreement.</p> <p>Major International organisations and initiatives: United Nations Environment Programme (UNEP), United Nations Educational, Scientific and Cultural Organization (UNESCO), Intergovernmental Panel on Climate Change (IPCC).</p> |                                                                        |  |  |
| <p>Targeted Application &amp; Tools that can be used:</p> <p>Application areas are Energy, Environment and sustainability</p> <p>Tools: Online Tools – NPTEL and Swayam.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                        |  |  |
| Project work/Assignment:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                        |  |  |
| Assessment Type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                        |  |  |
| <ul style="list-style-type: none"> <li>Online exams (MCQs) will be conducted by the department of Chemistry</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                        |  |  |
| Online Link*:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                        |  |  |
| <ol style="list-style-type: none"> <li>Lecture by Dr. Samik Chowdhury, Dr. Sudha Goel, NPTEL course: Environmental Science, <a href="https://nptel.ac.in/courses/109105203">https://nptel.ac.in/courses/109105203</a>, 2024.</li> <li>Lecture by Dr. Padmavati, Dr Narendran Thiruthy, NPTEL Course: Biodiversity Protection, Farmers and Breeders Rights, <a href="https://nptel.ac.in/courses/129105008">https://nptel.ac.in/courses/129105008</a>, 2024.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                        |  |  |
| * Other source links are available in below Resources link.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                        |  |  |

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| Text Book                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |  |  |  |  |  |  |
| <ol style="list-style-type: none"> <li>1. G. Tyler Miller and Scott Spoolman (2020), Living in the Environment, 20<sup>th</sup> Edition, Cengage Learning, USA</li> <li>2. Poonia, M.P. Environmental Studies (3rd ed.), Khanna Book Publishing Co.</li> <li>3. Bharucha, E. Textbook of Environmental Studies (3rd ed.) Orient Blackswan Private Ltd.</li> <li>4. Dave, D., &amp; Katewa, S. S. Text Book of Environmental Studies. Cengage Learning India Pvt Ltd.</li> <li>5. Rajagopalan, R. Environmental studies: from crisis to cure (4th ed.). Oxford University Press.</li> <li>6. Basu, M., &amp; Xavier Savarimuthu, S. J. Fundamentals of environmental studies. Cambridge University Press.</li> <li>7. Roy, M. G. Sustainable Development: Environment, Energy and Water Resources. Ane Books.</li> <li>8. Pritwani, K. Sustainability of business in the context of environmental management. CRC Press.</li> <li>9. Wright, R.T. &amp; Boorse, D.F. Environmental Science: Toward A Sustainable Future (13th ed.). Pearson.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |  |  |  |  |  |  |
| Reference Books                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |  |  |  |  |  |  |
| <ol style="list-style-type: none"> <li>1. Varghese, Anita, Oommen, Meera Anna, Paul, Mridula Mary, Nath, Snehlata (Editors) (2022), Conservation through Sustainable Use: Lessons from India. Routledge.</li> <li>2. William P. Cunningham and Mary Ann Cunningham (2020), Principles of Environmental Science: Inquiry &amp; Applications, 9<sup>th</sup> Edition, McGraw-Hill Education, USA.</li> <li>3. Richard A. Marcantonio, Marc Lame (2022). Environmental Management: Concepts and Practical Skills. Cambridge University Press.</li> <li>4. Manahan, S.E. (2022). Environmental Chemistry (11th ed.). CRC Press. <a href="https://doi.org/10.1201/9781003096238">https://doi.org/10.1201/9781003096238</a></li> <li>5. Theodore, M. K. and Theodore, Louis (2021) Introduction to Environmental Management, 2<sup>nd</sup> Edition. CRC Press</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |  |  |  |  |  |  |  |
| Resources:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |  |  |  |  |  |  |
| <ol style="list-style-type: none"> <li>1. <a href="https://nptel.ac.in/courses/109105203">https://nptel.ac.in/courses/109105203</a></li> <li>2. <a href="https://archive.nptel.ac.in/courses/120/108/120108004/">https://archive.nptel.ac.in/courses/120/108/120108004/</a></li> <li>3. <a href="https://nptel.ac.in/courses/127105018">https://nptel.ac.in/courses/127105018</a></li> <li>4. <a href="https://onlinecourses.nptel.ac.in/noc23_lw06/preview">https://onlinecourses.nptel.ac.in/noc23_lw06/preview</a></li> <li>5. <a href="https://onlinecourses.swayam2.ac.in/ini25_bt02/preview">https://onlinecourses.swayam2.ac.in/ini25_bt02/preview</a></li> <li>6. <a href="https://archive.nptel.ac.in/courses/120/108/120108002/">https://archive.nptel.ac.in/courses/120/108/120108002/</a></li> <li>7. <a href="https://onlinecourses.swayam2.ac.in/ini25_bt02/preview">https://onlinecourses.swayam2.ac.in/ini25_bt02/preview</a></li> <li>8. <a href="https://nptel.ac.in/courses/102104088">https://nptel.ac.in/courses/102104088</a></li> <li>9. <a href="https://nptel.ac.in/courses/124107165">https://nptel.ac.in/courses/124107165</a></li> <li>10. <a href="https://nptel.ac.in/courses/109106200">https://nptel.ac.in/courses/109106200</a></li> <li>11. <a href="https://archive.nptel.ac.in/content/storage2/courses/120108004/module1/lecture1.pdf">https://archive.nptel.ac.in/content/storage2/courses/120108004/module1/lecture1.pdf</a></li> <li>12. <a href="https://onlinecourses.swayam2.ac.in/nou25_ge19/preview">https://onlinecourses.swayam2.ac.in/nou25_ge19/preview</a></li> <li>13. <a href="https://onlinecourses.swayam2.ac.in/ini25_hs01/preview">https://onlinecourses.swayam2.ac.in/ini25_hs01/preview</a></li> <li>14. <a href="http://kcl.digimat.in/nptel/courses/video/105105184/L32.html">http://kcl.digimat.in/nptel/courses/video/105105184/L32.html</a></li> <li>15. <a href="https://nptel.ac.in/courses/105105169">https://nptel.ac.in/courses/105105169</a></li> </ol> |  |  |  |  |  |  |  |
| Topics relevant to Skill Development:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |  |  |  |  |  |  |
| <ol style="list-style-type: none"> <li>1. An attitude of enquiry.</li> <li>2. Write reports</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |  |  |  |  |  |  |
| The topics related to Environment and Sustainability :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |  |  |  |  |  |  |
| All topics in theory component are relevant to Environment and Sustainability.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |  |  |  |  |  |  |

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|--------------------------------|------------------------------------------------------------------------------------------------|--------------|---|---|---|---|
| <b>Course Code:</b><br>MAT2321 | <b>Course Title:</b> Discrete Mathematical Structures<br><b>Type of Course:</b> 1] School Core | <b>P - C</b> | 3 | 1 | 0 | 4 |
| <b>Version No.</b>             | 1.0                                                                                            |              |   |   |   |   |
| <b>Course Pre-requisites</b>   | NIL                                                                                            |              |   |   |   |   |

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|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| <b>Anti-requisites</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                             |
| <b>Course Description</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | This course introduces the fundamental concepts of Discrete Mathematics, providing the mathematical foundations essential for computer science and related disciplines. It covers sets, relations, functions, closures, equivalence relations, and primitive recursive functions, followed by partially ordered sets, lattices, and Boolean algebras. The course also explores graph theory, including graph types, isomorphism, Euler and Hamiltonian paths, circuits, and graph coloring. In addition, students study algebraic structures such as semigroups, monoids, and groups, residue arithmetic, and group codes. Emphasis is placed on developing logical reasoning, mathematical modeling, and problem-solving skills applicable to computing, information systems, and network analysis.                                                                                                                                                                                                                                                                                                                                                                                    |                             |
| <b>Course Objective</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | The primary objective of this course is to provide students with a strong foundation in discrete mathematical structures and logical reasoning that underpin computer science and related disciplines. It aims to develop the ability to construct mathematical arguments, analyze discrete problems, and apply formal methods to problem solving. The course introduces fundamental concepts of logic, sets, relations, functions, Boolean algebra, graph theory, and algebraic structures such as semigroups, monoids, and groups, while also exploring formal languages and grammar. Through these topics, students will acquire the analytical and mathematical skills necessary for applications in algorithm design, digital systems, coding theory, cryptography, and other areas of computing.                                                                                                                                                                                                                                                                                                                                                                                  |                             |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <p>On successful completion of the course the students shall be able to:</p> <p><b>C01:</b> Apply propositional and predicate logic, logical equivalences, normal forms, inference rules, and proof techniques to analyze arguments and solve problems in mathematical reasoning and computer science. (L3)</p> <p><b>C02:</b> Apply the concepts of sets, relations, functions, closures, equivalence relations, and primitive recursive functions to model and solve problems in discrete mathematics and computer science. (L3)</p> <p><b>C03:</b> Employ partially ordered sets, lattices, Boolean algebras, and Boolean functions, and apply their properties to solve problems in discrete mathematical structures and logical systems. (L3)</p> <p><b>C04:</b> Apply the concepts of lattices, Boolean algebras, and Boolean functions to solve logical and computational problems. (L3)</p> <p><b>C05:</b> Apply graph theoretic concepts and techniques to solve problems in networks, connectivity, and optimization applications. (L3)</p> <p><b>C06:</b> Employ group theory and residue arithmetic techniques in coding, computation, and information processing. (L3)</p> |                             |
| <b>Course Content:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                             |
| <b>Module 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Fundamentals of Logic</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>(11L+4T=14 Sessions)</b> |
| Propositional Logic, Propositional Logic, Equivalences, Normal forms, Inference rules, Introduction to Proofs, Conversion to clausal form, Predicate calculus, The Statement function, Inference theory of the Predicate Calculus.<br>Compiler optimization and program correctness verification, Cybersecurity and cryptographic protocol verification.                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                             |
| <b>Module 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Relations and Functions</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>(10L+3T=13 Sessions)</b> |
| Sets and set-operations, Relations, Functions, Properties of Relations & Representations of Relation, closure of different types of relations, equivalence relations, primitive recursive function. Database Management Systems, Artificial Intelligence and Machine Learning.                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                             |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Boolean Algebra and Graph Theory</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>(13L+4T=17 Sessions)</b> |
| Partially Ordered Sets, Lattices, Boolean Algebras, Functions of Boolean Algebras, Boolean Functions as Boolean Polynomials. <b>Computer Networks:</b> Routing and switching logic. <b>Robotics:</b> Decision-making using Boolean logic.<br>Graph Theory-Basic Concept of Graph Theory, Types of Graphs, Isomorphism, Euler Paths and Circuits, Hamiltonian Paths and Circuits, Colouring of Graph. Social Networks (Facebook, Instagram, LinkedIn).and <b>GPS &amp; Navigation:</b> Shortest path and route optimization. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                             |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Groups</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>(11L+4T=15 Sessions)</b> |

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| Semi Groups, Monoids, Groups, The applications of Residue Arithmetic to Computers, Group codes. Functional programming and distributed systems. Compiler design and programming languages.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                        |
| <p>Targeted Application &amp; Tools that can be used:</p> <ul style="list-style-type: none"> <li>• Compiler optimization, program correctness verification, cybersecurity protocol verification, automated reasoning, formal software verification.</li> <li>• Database Management Systems (DBMS), Artificial Intelligence (AI), Machine Learning (ML), knowledge representation, data modeling and query processing.</li> <li>• Digital circuit design, computer networks (routing and switching), robotics decision-making systems, logic controller design, social network analysis, GPS and navigation systems, route optimization, communication networks, and recommendation systems.</li> <li>• Cryptography, error-correcting codes, compiler design, distributed systems, residue arithmetic in computer architecture.</li> </ul> <p>Software: MATLAB, Lean 4, Mathematica, Maple, Python, GeoGebra, Octave, R, Scilab.</p>                                 |                        |
| <b>Assignment:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                        |
| <p>Assignments will involve theoretical problem-solving and computational implementation using suitable programming tools. The assignments may be undertaken individually or in groups, as decided by the instructor. Additionally, experiential learning activities will be conducted using Lean 4, enabling students to develop formal proofs, verify logical propositions, and gain hands-on experience in theorem proving and formal verification.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                        |
| <b>Text Book</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |
| <ol style="list-style-type: none"> <li>6. K. H. Rosen, <i>Discrete Mathematics and Its Applications</i>, 8th ed. New York, NY, USA: McGraw-Hill Education, 2019.</li> <li>7. F. Harary, <i>Graph Theory</i>. Reading, MA, USA: Addison-Wesley Publishing Company, 1969.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                        |
| <b>References:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                        |
| <ol style="list-style-type: none"> <li>1. S. Epp, <i>Discrete Mathematics with Applications</i>, 5th ed. Boston, MA, USA: Cengage Learning, 2019.</li> <li>2. K. A. Ross and C. R. B. Wright, <i>Discrete Mathematics</i>, 6th ed. New Delhi, India: Pearson Education, 2018.</li> <li>3. L. Mott, A. Kandel, and T. P. Baker, <i>Discrete Mathematics for Computer Scientists and Mathematicians</i>, 3rd ed. New Delhi, India: PHI Learning, 2016.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                        |
| <b>E-resources/ Web links:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                        |
| <ol style="list-style-type: none"> <li>4. <a href="https://presiuniv.knimbus.com/portal/v2/default/viewDetail?searchResultType=ECAT ALOGUE BASED&amp;uniqueId=TEXTBOOK LIBRARY01 06082022 289">https://presiuniv.knimbus.com/portal/v2/default/viewDetail?searchResultType=ECAT ALOGUE BASED&amp;uniqueId=TEXTBOOK LIBRARY01 06082022 289</a></li> <li>5. <a href="https://presiuniv.knimbus.com/portal/v2/default/viewDetail?searchResultType=ECAT ALOGUE BASED&amp;uniqueId=DOAB 1 06082022 8919">https://presiuniv.knimbus.com/portal/v2/default/viewDetail?searchResultType=ECAT ALOGUE BASED&amp;uniqueId=DOAB 1 06082022 8919</a></li> <li>6. <a href="https://nptel.ac.in/courses/106108227">https://nptel.ac.in/courses/106108227</a></li> <li>7. <a href="https://nptel.ac.in/courses/111106102">https://nptel.ac.in/courses/111106102</a></li> <li>8. <a href="https://nptel.ac.in/courses/111106113">https://nptel.ac.in/courses/111106113</a></li> </ol> |                        |
| <p><b>Topics relevant to SKILL DEVELOPMENT:</b> The course develops skills in logical reasoning, mathematical modeling, problem-solving, algorithmic thinking, and graph analysis through the study of logic, relations, Boolean algebra, and graph theory. It also enhances computational and analytical skills by applying algebraic structures, formal languages, recursion, and coding techniques to real-world computing problems.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                        |
| <b>Catalogue prepared by</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>Dr. Obbu Ramesh</b> |
| <b>Recommended by the Board of Studies on</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                        |
| <b>Date of Approval by the Academic Council</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                        |

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| Course Code:<br>CSS2258                                                                                                                                                                                                                                                                                                                                                                          | Course Title: Web Technologies<br>Type of Course : Theory Course (PCC)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | L-T-P- C    | 3 – 0 – 0 - 3 |
| Version No.                                                                                                                                                                                                                                                                                                                                                                                      | 2.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |               |
| Course Pre-requisites                                                                                                                                                                                                                                                                                                                                                                            | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |               |
| Anti-requisites                                                                                                                                                                                                                                                                                                                                                                                  | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |               |
| Course Description                                                                                                                                                                                                                                                                                                                                                                               | This course highlights the fundamentals of web design using Hypertext Markup Language and Cascading Style Sheets. Students will be trained in planning and designing effective web pages by writing code using current web technologies, enhancing web pages with layout techniques, text formatting, graphics, images, and multimedia. The course focuses on key technologies required to build Internet- and web-based applications that interact with databases and other applications. It also introduces concepts of secure web development, intelligent web applications, and AI-enabled web technologies.                                                          |             |               |
| Course Objective                                                                                                                                                                                                                                                                                                                                                                                 | To develop a strong foundation in web technologies by enabling students to understand internet protocols, design and develop static and dynamic web applications, explore client-side scripting and frameworks, implement server-side programming with database integration, evaluate modern web application architectures, and develop secure and intelligent web applications using AI concepts.                                                                                                                                                                                                                                                                        |             |               |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                  | On successful completion of this course, students will be able to:<br>CO1: Explain the fundamentals of web technologies, XHTML structure, and web architecture concepts. Level 2 – Understand<br>CO2: Apply CSS and advanced styling techniques to design responsive and interactive web pages. Level 3 – Apply<br>CO3: Develop dynamic web applications using JavaScript, DOM manipulation, and event handling techniques. Level 3 – Apply<br>CO4: Build server-side web applications using PHP and database connectivity concepts. Level 3 – Apply<br>CO5: Apply web technologies to develop secure and intelligent web applications using AI concepts. Level 3 – Apply |             |               |
| Course Content:                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |               |
| Module 1                                                                                                                                                                                                                                                                                                                                                                                         | Introduction to XHTML                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 10 Sessions |               |
| Topics:<br>Basics: Web, WWW, Web browsers, Web servers, Internet.<br>XHTML: Origins and Evolution of HTML and XHTML: Basic Syntax, Standard XHTML Document Structure, Basic Text Markup, Images, Hypertext Links, Lists, Tables, Forms, Frames, Syntactic Differences between HTML and XHTML.                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |               |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                         | Advanced CSS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 10 Sessions |               |
| Topics:<br>CSS: Introduction to CSS, Defining & Applying a style, Creating style sheets, types of style sheet, selectors, CSS font properties, border properties, Box model, opacity, CSS pseudo class and pseudo-elements<br>Advanced CSS: Layout, Normal Flow, Positioning Elements, Floating Elements, Responsive Design, CSS Frameworks XML: Basics, demonstration of applications using XML |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |               |
| Module 3                                                                                                                                                                                                                                                                                                                                                                                         | Fundamentals of JavaScript                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 10 Sessions |               |
| Topics:<br>JavaScript: Introduction to JavaScript, Basic JavaScript Instructions, Functions, Methods & Objects, Decisions and Loops, Document Object Model, Event handling, handling window pop-ups, JavaScript validation.                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |               |

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| Module 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | PHP – Application Level          | 08 Sessions |
| <b>Topics:</b><br>PHP: Introduction to server-side Development with PHP, Arrays, \$GET and \$ POST, \$_Files Array, Reading/Writing Files, PHP Classes and Objects, Working with Databases, SQL, Database APIs, Managing a MySQL Database. Accessing MySQL in PHP.                                                                                                                                                                                                                                                                                                 |                                  |             |
| Module 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Web Security and AI Applications | 07 Sessions |
| Web Security Basics, Secure Web Development, Input Validation and Session Handling, Secure PHP and Database Access, Introduction to AI in Web Applications, AI-based Chatbots, Intelligent User Interfaces, Smart Web Applications.                                                                                                                                                                                                                                                                                                                                |                                  |             |
| <b>Targeted Application &amp; Tools that can be used:</b><br>Xampp web server to be used to demonstrate PHP.                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                  |             |
| <b>Project work/Assignment:</b><br>Assignments are given after completion of each module which the student need to submit within the stipulated deadline.                                                                                                                                                                                                                                                                                                                                                                                                          |                                  |             |
| <b>Textbook(s):</b><br>T1. Robert. W. Sebesta, "Programming the World Wide Web", Pearson Education, 8th Edition, 2015.<br>T2. CSS Notes for Professionals, ebook available at <a href="https://books.goalkicker.com/CSSBook/">https://books.goalkicker.com/CSSBook/</a> (Retrieved on Jan. 20, 2022)<br>T3. Deitel, Deitel, Goldberg, "Internet & World Wide Web How to Program", Fifth Edition, Pearson Education, 2021.                                                                                                                                          |                                  |             |
| <b>References:</b><br>R1. Randy Connolly, Ricardo Hoar, "Fundamentals of Web Development", Pearson Education India, 1st Edition, 2016.<br>R2. Jeffrey C. Jackson, "Web Technologies: A Computer Science Perspective", Pearson Education, 1st Edition, 2016.                                                                                                                                                                                                                                                                                                        |                                  |             |
| <b>Topics related to development of "FOUNDATION":</b> Web, WWW, Web browsers, Web servers, Internet. CSS, PHP. Designing for healthcare.<br>For Skill Development through Experiential Learning techniques. This is attained through assessment component mentioned in course handout.                                                                                                                                                                                                                                                                             |                                  |             |
| <b>E-References:</b> <ol style="list-style-type: none"> <li>1. <a href="http://W3schools.com">W3schools.com</a></li> <li>2. <a href="http://Developer.mozilla.org/en-US/docs/Learn">Developer.mozilla.org/en-US/docs/Learn</a></li> <li>3. <a href="http://docs.microsoft.com">docs.microsoft.com</a></li> <li>4. <a href="http://informit.com/articles/">informit.com/articles/</a> The Relationship Between Web 2.0 and Social Networking</li> <li>5. <a href="https://presiuniv.knimbus.com/user#/home">https://presiuniv.knimbus.com/user#/home</a></li> </ol> |                                  |             |

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|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|---------|
| Course Code:<br>CSS2259 | Course Title: Web Technologies Lab<br>Type of Course: Laboratory Course (PCC)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | L- T-P- C | 0-0-2-1 |
| Version No.             | 2.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |         |
| Course Pre-requisites   | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |         |
| Anti-requisites         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |         |
| Course Description      | This course highlights the fundamentals of web design using Hypertext Markup Language and Cascading Style Sheets. Students will be trained in planning and designing effective web pages by writing code using current web technologies, enhancing web pages with layout techniques, text formatting, graphics, images, and multimedia. The course focuses on key technologies required to build Internet- and web-based applications that interact with databases and other applications. It also introduces concepts of secure web development, intelligent web applications, and AI-enabled web technologies. |           |         |

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| Course Objective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To develop a strong foundation in web technologies by enabling students to understand internet protocols, design and develop static and dynamic web applications, explore client-side scripting and frameworks, implement server-side programming with database integration, evaluate modern web application architectures, and develop secure and intelligent web applications using AI concepts.                                                                                                                                                                                                                                                                                                   |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <p>On successful completion of this course, students will be able to:</p> <p>CO1: Explain the fundamentals of web technologies, XHTML structure, and web architecture concepts. Level 2 – Understand</p> <p>CO2: Apply CSS and advanced styling techniques to design responsive and interactive web pages. Level 3 – Apply</p> <p>CO3: Develop dynamic web applications using JavaScript, DOM manipulation, and event handling techniques. Level 3 – Apply</p> <p>CO4: Build server-side web applications using PHP and database connectivity concepts. Level 3 – Apply</p> <p>CO5: Apply web technologies to develop secure and intelligent web applications using AI concepts. Level 3 – Apply</p> |
| <b>COURSE CONTENT:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| List of Laboratory Tasks:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 30 Sessions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <p>WEEK 1: Introduction to Web &amp; XHTML</p> <p>Lab Sheet 1: Web Basics</p> <p>Level 1: Create a simple XHTML page explaining Web, WWW, browsers, and servers.</p> <p>Level 2: Design a webpage illustrating Internet architecture using text and images.</p> <p>Lab Sheet 2: XHTML Structure</p> <p>Level 1: Create a basic XHTML document with proper syntax and structure.</p> <p>Level 2: Design a webpage using headings, paragraphs, and formatting tags.</p> <p>WEEK 2: XHTML Elements</p> <p>Lab Sheet 3: Lists and Links</p> <p>Level 1: Create ordered, unordered, and definition lists in XHTML.</p> <p>Level 2: Create hyperlinks for navigation between multiple pages.</p> <p>Lab Sheet 4: Images and Tables</p> <p>Level 1: Insert images into a webpage.</p> <p>Level 2: Design a table with rows, columns, and formatting.</p> <p>WEEK 3: XHTML Forms &amp; Frames</p> <p>Lab Sheet 5: Forms</p> <p>Level 1: Create a form with text fields and buttons.</p> <p>Level 2: Design a registration form with validation requirements.</p> <p>Lab Sheet 6: Frames</p> <p>Level 1: Create a webpage using frames.</p> <p>Level 2: Design a multi-frame layout for a website.</p> <p>WEEK 4: Introduction to CSS</p> <p>Lab Sheet 7: CSS Basics</p> <p>Level 1: Apply inline and internal CSS styles.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

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|                                       | Level 2: Create an external stylesheet and apply it to multiple pages. |
| Lab Sheet 8: Selectors                |                                                                        |
|                                       | Level 1: Use element, class, and ID selectors.                         |
|                                       | Level 2: Apply multiple selectors for styling complex pages.           |
| WEEK 5: CSS Properties                |                                                                        |
| Lab Sheet 9: Font and Text            |                                                                        |
|                                       | Level 1: Apply font properties (size, style, family).                  |
|                                       | Level 2: Design a styled webpage using text formatting.                |
| Lab Sheet 10: Box Model               |                                                                        |
|                                       | Level 1: Demonstrate margin, padding, and border.                      |
|                                       | Level 2: Design layout using box model concepts.                       |
| WEEK 6: Advanced CSS                  |                                                                        |
| Lab Sheet 11: Positioning             |                                                                        |
|                                       | Level 1: Use static and relative positioning.                          |
|                                       | Level 2: Design layout using absolute and fixed positioning.           |
| Lab Sheet 12: Floating & Layout       |                                                                        |
|                                       | Level 1: Apply float properties.                                       |
|                                       | Level 2: Create a multi-column layout using float.                     |
| WEEK 7: Responsive Design             |                                                                        |
| Lab Sheet 13: Responsive Web Design   |                                                                        |
|                                       | Level 1: Use media queries.                                            |
|                                       | Level 2: Design a responsive webpage.                                  |
| Lab Sheet 14: CSS Frameworks          |                                                                        |
|                                       | Level 1: Use a CSS framework (Bootstrap basics).                       |
|                                       | Level 2: Design responsive webpage using Bootstrap.                    |
| WEEK 8: XML Basics                    |                                                                        |
| Lab Sheet 15: XML Structure           |                                                                        |
|                                       | Level 1: Create a simple XML document.                                 |
|                                       | Level 2: Display XML data in webpage.                                  |
| Lab Sheet 16: XML Applications        |                                                                        |
|                                       | Level 1: Validate XML structure.                                       |
|                                       | Level 2: Use XML for data representation in web pages.                 |
| WEEK 9: JavaScript Basics             |                                                                        |
| Lab Sheet 17: JavaScript Introduction |                                                                        |
|                                       | Level 1: Write basic JavaScript program for output.                    |
|                                       | Level 2: Perform arithmetic operations using JavaScript.               |
| Lab Sheet 18: Control Statements      |                                                                        |
|                                       | Level 1: Use if-else statements.                                       |
|                                       | Level 2: Implement loops in JavaScript.                                |
| WEEK 10: Functions & DOM              |                                                                        |
| Lab Sheet 19: Functions               |                                                                        |
|                                       | Level 1: Create and call functions.                                    |
|                                       | Level 2: Use functions with parameters and return values.              |
| Lab Sheet 20: DOM Manipulation        |                                                                        |
|                                       | Level 1: Access HTML elements using DOM.                               |
|                                       | Level 2: Modify content dynamically using JavaScript.                  |
| WEEK 11: Events & Validation          |                                                                        |
| Lab Sheet 21: Event Handling          |                                                                        |
|                                       | Level 1: Handle click events.                                          |
|                                       | Level 2: Create interactive webpage using events.                      |
| Lab Sheet 22: Form Validation         |                                                                        |
|                                       | Level 1: Validate input fields using JavaScript.                       |

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| <p>Level 2: Create complete form validation system.</p> <p>WEEK 12: Advanced JavaScript</p> <p>Lab Sheet 23: Objects &amp; Methods</p> <p>Level 1: Create JavaScript objects.</p> <p>Level 2: Use methods and object properties.</p> <p>Lab Sheet 24: Pop-ups</p> <p>Level 1: Implement alert and prompt.</p> <p>Level 2: Create dynamic pop-up-based interaction.</p> <p>WEEK 13: PHP Basics</p> <p>Lab Sheet 25: PHP Introduction</p> <p>Level 1: Write basic PHP script.</p> <p>Level 2: Handle form input using PHP.</p> <p>Lab Sheet 26: PHP Control Structures</p> <p>Level 1: Use if-else in PHP.</p> <p>Level 2: Implement loops in PHP.</p> <p>WEEK 14: PHP Applications</p> <p>Lab Sheet 27: PHP Forms</p> <p>Level 1: Process form data using PHP.</p> <p>Level 2: Create login system using PHP.</p> <p>Lab Sheet 28: PHP File Handling</p> <p>Level 1: Read/write files using PHP.</p> <p>Level 2: Store and retrieve data dynamically.</p> <p>WEEK 15: Integration &amp; Mini Project</p> <p>Lab Sheet 29: Web Integration</p> <p>Level 1: Combine XHTML, CSS, JavaScript.</p> <p>Level 2: Build dynamic webpage using all technologies.</p> <p>Lab Sheet 30: Mini Project</p> <p>Level 1: Design a complete website.</p> <p>Level 2: Develop full web application using XHTML, CSS, JS, PHP.</p> <p>WEEK 15.1: Secure and Intelligent Web Applications</p> <p>Lab Sheet 31: Web Security and Smart Interfaces</p> <p>Level 1: Implement secure form validation and session handling in web applications.</p> <p>Level 2: Develop an intelligent web interface with chatbot or recommendation features.</p> <p>Lab Sheet 32: AI-based Web Mini Project</p> <p>Level 1: Design a secure responsive web application.</p> <p>Level 2: Develop a smart web application integrating XHTML, CSS, JavaScript, PHP, and basic AI concepts.</p> <p><b>Targeted Application &amp; Tools that can be used:</b></p> <p>Xampp web server to be used to demonstrate PHP.</p> <p><b>Project work/Assignment:</b></p> <p>Assignments are given after completion of each module which the student need to submit within the stipulated deadline.</p> <p><b>Textbook(s):</b></p> <p>T1. Robert. W. Sebesta, "Programming the World Wide Web", Pearson Education, 8th Edition, 2015.</p> <p>T2. CSS Notes for Professionals, ebook available at <a href="https://books.goalkicker.com/CSSBook/">https://books.goalkicker.com/CSSBook/</a> (Retrieved on Jan. 20, 2022)</p> <p>T3. Deitel, Deitel, Goldberg, "Internet &amp; World Wide Web How to Program", Fifth Edition, Pearson Education, 2021.</p> <p><b>References:</b></p> <p>R1. Randy Connolly, Ricardo Hoar, "Fundamentals of Web Development", Pearson Education</p> |
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| <p>India,1st. Edition.2016.<br/> R2. Jeffrey C. Jackson,"Web Technologies: A Computer Science Perspective", Pearson Education, 1<sup>st</sup> Edition,2016.</p> <p><b>E-References:</b></p> <ol style="list-style-type: none"> <li>1. <a href="http://W3schools.com">W3schools.com</a></li> <li>2. <a href="http://Developer.mozilla.org/en-US/docs/Learn">Developer.mozilla.org/en-US/docs/Learn</a></li> <li>3. <a href="http://docs.microsoft.com">docs.microsoft.com</a></li> <li>4. <a href="http://informit.com/articles/">informit.com/articles/</a> The Relationship Between Web 2.0 and Social Networking</li> <li>5. <a href="https://presiuniv.knimbus.com/user#/home">https://presiuniv.knimbus.com/user#/home</a></li> </ol> <p>Topics related to development of "FOUNDATION": Web, WWW, Web browsers, Web servers, Internet. CSS, PHP. Designing for healthcare For Skill Development through Experiential Learning techniques. This is attained through assessment component mentioned in course handout.</p> |
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| Course Code:<br>CSS2260 | Course Name: Database Management Systems<br>Type of Course: Theory Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | L- T-P- C | 3-0-0-3 |
| Version No.             | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |           |         |
| Course prerequisites    | Pre-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | NIL       |         |
| Co-requisites           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           |         |
| Anti-requisites         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |           |         |
| Course Description      | This course introduces the foundational principles of database management systems, including data models, schemas, and architecture. This course provides a solid foundation on the relational model of data and the use of relational algebra. It develops skills in SQL for data definition, manipulation, and control, enabling students to construct and execute complex queries. The course also introduces the concept of object oriented and object relational databases and modern database technologies like NoSQL. The also course allows the students to gain insights into data storage structures and indexing strategies for optimizing query performance. |           |         |
| Course Objective        | The objective of the course is to familiarize the learners with the concepts of Database Management Systems and attain Employability through Problem Solving Methodologies.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |         |
| Course Outcomes         | <b>On successful completion of the course the students shall be able to:</b><br><br><b>C01:</b> Describe the fundamental elements of relational database[Level 2 - Understand] management systems.<br><b>C02:</b> Examine databases using SQL query processing and[Level 3 – Apply] Optimization.<br><b>C03:</b> Design simple database systems applying the[Level 3 – Apply] normalization constraints and demonstrate the database transaction processing, recovery, and security.<br><b>C04:</b> Interpret the concept of advanced databases and its[Level 3 – Apply] applications.                                                                                   |           |         |
| Course Content:         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           |         |

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| Module 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Introduction to Database Modelling and Relational Algebra | Assessment: Assignment (Problem Solving) | 10 Sessions |
| <p>Topics:</p> <p>Introduction to Database: Schema, Instance, 3-shema architecture, physical and logical data independence, Data isolation problem in traditional file system, advantages of database over traditional file systems. Entity Relationship (ER) Model, ER Model to Relational Model, Examples on ER model. Relational Algebra with selection, projection, rename, set operations, Cartesian product, joins (inner and outer joins), and division operator. Examples on Relational Algebra Operations.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                           |                                          |             |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Fundamentals of SQL and Query Optimization                | Assessment : Assignment (Programming)    | 11 Sessions |
| <p>Topics:</p> <p>SQL Database Querying, DDL, DML, Constraints, Operators, Set Operators, Aggregate Functions, Joins, Views, Procedures, Functions and Triggers.</p> <p>Database programming issues and techniques: Embedded SQL, Dynamic SQL; SQL / PSM and NoSQL.</p> <p>Query Optimization: Purpose, transformation of relational expressions, estimating cost and statistics of expression, choosing evaluation plans, linear and bushy plans, dynamic programming algorithms.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                           |                                          |             |
| Module 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Relational Database Design & Transaction Management       | Assessment: Assignment (Problem Solving) | 12 Sessions |
| <p>Topics:</p> <p>Relational database design: Problems in schema design, redundancy and anomalies, Normal Forms based on Primary Keys-(1NF,2NF, 3NF), Boyce-Codd Normal Form, Multi valued Dependency (Fourth Normal Form), Join Dependencies (Fifth Normal Form), lossy and lossless decompositions, Database De-normalization.</p> <p>Transaction Management: The ACID Properties; Transactions and Schedules; Concurrent Execution of Transactions; Lock- Based Concurrency Control; Performance of locking; Transaction support in SQL; Introduction to crash recovery; 2PL, Serializability and Recoverability; Lock Management; The write-ahead log protocol; Check pointing; Recovering from a System Crash; Media Recovery; Other approaches and interaction with concurrency control.</p>                                                                                                                                                                                                       |                                                           |                                          |             |
| Module 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Advanced DBMS Topics                                      | Assessment : Assignment (Case Study)     | 12 Sessions |
| <p>Topics:</p> <p>Advanced topics: Object oriented database management systems, Deductive databasemanagement systems, Spatial database management systems, Temporal database management systems, Constraint database management systems.</p> <p>New database applications and architectures such as Data warehousing, Multimedia, Mobility, NoSQL, Native XML databases (NXD), Document-oriented databases, Statistical databases.</p> <p>Targeted Applications &amp; Tools:</p> <p>Application Area: Relational database systems for Business, Scientific and Engineering Applications.</p> <p>Tools/Simulator used: MySQL DB for student practice.</p> <p>Also demonstration of ORACLE DB on object-relational database creation and JDBC connection.</p> <p>1. Problem Solving: Constructing ER-Diagrams for a given real time requirements, Normalizing the databases, querying the databases using relational algebra.</p> <p>2. Programming: Implementation of any given scenario using MySQL.</p> |                                                           |                                          |             |
| Skill-Building Activities through Experiential Learning:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                           |                                          |             |
| <p>Text Book</p> <p><b>T1:</b> Elmasri R and Navathe S B, “Fundamentals of Database System”, Pearson Publication, 7th Edition, 2018.</p> <p><b>T2:</b> RamaKrishna &amp; Gehrke, “Database Management Systems” 3rd Edition, 2018, McGraw-Hill Education.</p> <p><b>T3:</b> W. Lemahieu, S. vanden Broucke and B. Baesens, “Principles of Database Management: Practical Guide to Storing, Managing and Analyzing Big and Small Data”, Cambridge University Press, 2018.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                           |                                          |             |

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| References                                                                                                                                                                                                                                                                     |
| <b>R1:</b> Avi Silberschatz, Henry F. Korth, S. Sudarshan, "Database System Concepts", McGraw-Hill ,7th Edition, 2019.<br><b>R2:</b> M. Kleppmann, "Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems", O'Reilly, 2017. |
| E-Resources/Web Resources                                                                                                                                                                                                                                                      |

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| Course Code:<br>CSS2261                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Course Name: Database Management Systems Lab<br>Type of Course: Laboratory Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | L- T-P- C | 0-0-2-1 |
| Version No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |         |
| Course Pre-requisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |         |
| Co-requisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |         |
| Anti-requisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |         |
| Course Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | The Database Management Systems (DBMS) Laboratory is designed to provide students with hands-on experience in database design, implementation, and management using SQL and database management tools such as MySQL. The lab complements theoretical concepts learned in database courses by allowing students to practice database creation, querying, and optimization techniques. The DBMS Lab enables students to develop industry-relevant skills in database management, preparing them for careers in software development, data engineering, and database administration. |           |         |
| Course Objective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | The objective of the course is to familiarize the learners with the concepts of Database Management Systems and attain Employability through Problem Solving Methodologies.                                                                                                                                                                                                                                                                                                                                                                                                       |           |         |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>On successful completion of the course the students shall be able to:</b><br><b>CO1:</b> Demonstrate the database concepts, practice, and SQL[Level 3 – Apply] queries.<br><b>CO2:</b> Design and implement database schemas while applying[Level 3 – Apply] normalization techniques to optimize structure.<br><b>CO3:</b> Develop and implement stored procedures, triggers, and[Level 3 – Apply] views for automation and efficiency.<br><b>CO4:</b> Design and build database applications for real world[Level 3 – Apply] problems.                                       |           |         |
| Course Content:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |         |
| <b>List of Laboratory Tasks:</b><br>Create Employee, Student, Banking and Library databases and populate them with required data. Do the following experiments of different lab sheets on those databases.<br><br>Labsheet-1 [3 Practical Sessions]<br><b>Experiment No 1: [ 1 Session]</b><br>1. To study and implement the different language of Structured Query Language.<br>Level 1: Perform operations using Data Definition Language and Data Manipulation Language commands including different variants of SELECT on Student DB.<br>Level 2: Identify the given requirements; valid attributes and data types and Perform DDL and DML operations on a given scenario. [Banking Databases]<br><br><b>Experiment No. 2: [2 Sessions]</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |         |

2. To study and implement the concept of integrity constraints in SQL.

Level 1: Create tables on Banking database using PRIMARY KEY, NOT NULL, UNIQUE, FOREIGN KEY and demonstrate the working of relational, logical, pattern matching, BETWEEN, IS NULL, IN and NOT IN Special Operators on Student Database.

Level 2: Enforce different types of data and referential integrity constraints. Then try queries with special operators based on the student database. [Banking Database].

### **Labsheet-2 [3 Practical Sessions]**

#### **Experiment No. 3: [ 1 Session]**

3. Implement complex queries in SQL.

Level 1: Implement the conjugate of GROUP BY, ORDER BY and aggregate functions on Banking Database.

Level 2: Implement MySQL DB queries on library database using appropriate clauses and aggregate functions. Also order the data either in ascending and descending order using corresponding clause. [Library databases].

#### **Experiment No. 4: [ 2 Session]**

4. To study and implement different types of Set and Join Operations [ 2 Slots]

Level 1: Demonstrate different types of Set Operations (UNION, UNION ALL, INTERSECT, MINUS) and Join Operations (INNER JOINS, OUTER JOINS, CROSS JOIN, NATURAL JOIN) on two or more tables of Airline Database. Level 2: Use Set and Join operations to retrieve the data from two or more relations (tables) as per the given

scenario. [Airline Database]

### **Labsheet-3 [2 Practical Sessions]**

#### **Experiment No. 5: [2 sessions]**

5. To study and implement Views, and Procedures in MySQL DB.

Level 1: Implement MySQL Views, and Procedures in ORACLE DB on Employee database.

Level 2: Analyze the requirement and construct views, and Procedures on Mini Project Domain. [Banking Database]

### **Labsheet-4 [2 Practical Sessions]**

#### **Experiment No. 6: [2 Sessions]**

6. To study and implement Functions, and Triggers in MySQL DB.

Level 1: Implement Oracle Functions and Triggers in Oracle on Employee database.

Level 2: Analyze the requirement and construct Functions and Triggers. [Supply chain Database]

### **Labsheet-5 [2 Practical Sessions]**

#### **Experiment No. 7: [2 Sessions]**

7. To study and implement Functions, and Triggers in MySQL DB.

Level 1: Implement Oracle Functions and Triggers in Oracle on Employee database.

Level 2: Determine the requirement and construct Functions and Triggers. [Supply chain Database]

### **Labsheet-6 [4 Practical Sessions]**

#### **Experiment No. 8: [2 Sessions]**

8. To implement the concept of forms and reports.

Level 1: Implement the concept of forms and reports.

Level 2: Examine the schema relationship.

#### **Experiment No. 9: [2 Sessions]**

9. Create the database using the given schema. (Flight Management)

Level 1: Implement a relational database based on the provided schema for the Flight Management system, including the creation of tables, relationships, and constraints.

Level 2: Demonstrate schema relationships by defining primary and foreign keys to ensure data integrity within the Flight Management database.

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| <b>Labsheet-7 [4 Practical Sessions]</b>                                                                                                                                                                |  |
| <b>Experiment No. 10: [2 Sessions]</b>                                                                                                                                                                  |  |
| 10. Create the database using the given schema. (Company database)                                                                                                                                      |  |
| Level 1: Implement the database schema by defining tables, relationships, and constraints according to the given Company Database schema.                                                               |  |
| Level 2: Demonstrate the schema's relationships and data integrity by creating and linking tables as per the specified requirements.                                                                    |  |
| <b>Experiment No. 11: [2 Sessions]</b>                                                                                                                                                                  |  |
| 11. Create the database using the given schema. (Student Library)                                                                                                                                       |  |
| Level 1: Implement forms and reports based on the provided Student Library database schema, ensuring effective data entry and reporting mechanisms.                                                     |  |
| Level 2: Demonstrate the schema relationships within the Student Library database, demonstrating how these relationships influence the creation and functionality of forms and reports.                 |  |
| <b>Labsheet-8 [ 1 Sessions]</b>                                                                                                                                                                         |  |
| 12. Design a mini project based on the databases such as Inventory Management System, University Management System, Hospital Management System, etc.                                                    |  |
| Level 1: Implement the real time database.                                                                                                                                                              |  |
| Level 2: Analyze the working of database in real time.                                                                                                                                                  |  |
| Targeted Applications & Tools:                                                                                                                                                                          |  |
| Skill-Building Activities through Experiential Learning:                                                                                                                                                |  |
| Text Book                                                                                                                                                                                               |  |
| <b>T1:</b> Elmasri R and Navathe S B, "Fundamentals of Database System", Pearson Publication, 7th Edition, 2018.                                                                                        |  |
| <b>T2:</b> RamaKrishna & Gehrke, "Database Management Systems" 3rd Edition, 2018, McGraw-Hill Education.                                                                                                |  |
| <b>T3:</b> W. Lemahieu, S. vanden Broucke and B. Baesens, "Principles of Database Management: Practical Guide to Storing, Managing and Analyzing Big and Small Data", Cambridge University Press, 2018. |  |
| References                                                                                                                                                                                              |  |
| <b>R1:</b> Avi Silberschatz, Henry F. Korth, S. Sudarshan, "Database System Concepts", McGraw-Hill ,7th Edition, 2019.                                                                                  |  |
| <b>R2:</b> M. Kleppmann, "Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems", O'Reilly, 2017.                                                    |  |
| E-Resources/Web Resources                                                                                                                                                                               |  |

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|------------------------------|-----------------------------------------------------------------------------------------------|----------------|---------|
| <b>CourseCode:</b> ADS2107   | <b>Course Name:</b> Exploratory Data Analysis<br><b>Type of Course:</b> Theory Course         | <b>L-T-P-C</b> | 3-0-0-3 |
| <b>Version No.</b>           | 1.0                                                                                           |                |         |
| <b>NCrF Level-</b>           | 5.0                                                                                           |                |         |
| <b>Course Pre-requisites</b> | Probability and Statistics; Computational Thinking using Python; Introduction to Data Science |                |         |
| <b>Co-requisites</b>         | NIL                                                                                           |                |         |
| <b>Anti-requisites</b>       | NIL                                                                                           |                |         |

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| CourseDescription                                                                                                                                                                                                                                                                                                      | This course introduces the fundamental techniques used to explore, summarize, and visualize datasets prior to applying predictive models. It focuses on statistical thinking, data preprocessing, and visualization methods that help uncover patterns, trends, and anomalies in data. Students will learn how to analyze structured datasets using exploratory techniques and develop insights that support data-driven decision making using tools such as Python, Pandas, and visualization libraries.                                                                                                                                                                                                                                                                                      |                                                                             |            |
| CourseObjective                                                                                                                                                                                                                                                                                                        | This course is designed to improve the learners' EMPLOYABILITY SKILLS by using experiential learning techniques in analyzing and visualizing real-world datasets                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                             |            |
| CourseOutcomes                                                                                                                                                                                                                                                                                                         | <b>On successful completion of the course the student shall be able to:</b><br><br><b>C01:</b> Explain the principles and importance of exploratory [Level 2- Understand] data analysis in data science workflows<br><b>C02:</b> Apply statistical and visualization techniques to [Level 3 – Apply] summarize and explore datasets..<br><b>C03:</b> Analyze relationships, patterns, and anomalies in [Level 4 – Analyze] datasets using exploratory data analysis methods.<br><b>C04:</b> Analyze data preprocessing techniques such as handling [Level 4- Analyze] missing values, outlier detection, and data transformation for improving data quality.<br><b>C05:</b> Analyze data exploration workflows to support machine [Level 4- Analyze] learning and data-driven decision making. |                                                                             |            |
| CourseContent:                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                             |            |
| Module 1                                                                                                                                                                                                                                                                                                               | Introduction to Exploratory Data Analysis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Assessment: Assignment (Python-based Descriptive Statistics and EDA)        | 9 Sessions |
| Data science workflow – Role of EDA in data analysis – Types of data (structured, unstructured) – Data sources – Data quality and data issues – Descriptive statistics – Measures of central tendency (mean, median, mode) – Measures of dispersion (variance, standard deviation) – Understanding data distributions. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                             |            |
| Module 2                                                                                                                                                                                                                                                                                                               | Data Cleaning and Preprocessing                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Assessment: Quiz + Assignment (Data Cleaning using Python/pandas)           | 9 Sessions |
| Handling missing values – Outlier detection and treatment – Data transformation – Normalization and standardization – Data integration – Data reduction techniques – Encoding categorical variables – Data wrangling using Python – Data quality assessment.                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                             |            |
| Module 3                                                                                                                                                                                                                                                                                                               | Data Visualization Techniques                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Assessment: Programming Assignment (Visualization using Matplotlib/Seaborn) | 9 Sessions |
| Principles of data visualization – Types of charts (bar, line, histogram, box plot, scatter plot) – Visualization best practices – Correlation analysis – Heatmaps – Pair plots – Multivariate visualization – Interactive visualization basics.                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                             |            |
| Module 4                                                                                                                                                                                                                                                                                                               | Pattern Discovery and Statistical Analysis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Assessment: Assignment (Statistical Analysis and Pattern Discovery)         | 9 Sessions |
| Feature analysis – Correlation and covariance – Hypothesis testing basics – Statistical relationships in data – Detecting patterns and trends – Anomaly detection – Time series exploration – Data interpretation techniques.                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                             |            |
| Module 5                                                                                                                                                                                                                                                                                                               | Advanced EDA and Case Studies                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Assessment: Mini                                                            | 9 Sessions |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                           | Project (End-to-End Exploratory Data Analysis) | s |
| Dimensionality reduction (PCA overview) – Feature selection techniques – EDA in machine learning pipeline – Real-world case studies (healthcare, finance, social media) – Visualization-driven insights – Reporting and storytelling using data – Tools for EDA (Python, Jupyter, Plotly).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                           |                                                |   |
| Targeted Applications & Tools:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                           |                                                |   |
| Python(NumPy,pandas)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Data manipulation, cleaning, and statistical analysis                                                                     |                                                |   |
| Matplotlib and Seaborn                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Basic and advanced data visualization techniques including plotting, statistical visualization, and correlation analysis. |                                                |   |
| Jupyter Notebook/Google Colab                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Interactive environment for performing exploratory data analysis.                                                         |                                                |   |
| Plotly for interactive visualization                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Interactive data visualization dashboards                                                                                 |                                                |   |
| Skill-Building Activities through Experiential Learning:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                           |                                                |   |
| <ul style="list-style-type: none"><li>• Data Cleaning and Preprocessing:<br/>Students work with real-world datasets to handle missing values, outliers, and inconsistent data using Python libraries such as Pandas and NumPy.</li><li>• Statistical Data Exploration:<br/>Learners apply descriptive statistics and distribution analysis to understand patterns and variability in datasets.</li><li>• Visualization for Pattern Discovery:<br/>Students create histograms, box plots, scatter plots, pair plots, and heatmaps to identify trends, correlations, and anomalies in data.</li><li>• Case Study-Based Data Analysis:<br/>Learners explore real-world datasets from healthcare, finance, and social media to extract insights and support data-driven decision making.</li></ul> |                                                                                                                           |                                                |   |
| Textbooks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                           |                                                |   |
| T1: John W. Tukey, Exploratory Data Analysis, Addison-Wesley.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                           |                                                |   |
| T2: Wes McKinney, Python for Data Analysis, O'Reilly Media, 3rd Edition, 2022.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                           |                                                |   |
| References                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                           |                                                |   |
| R1: Jake VanderPlas, Python Data Science Handbook, O'Reilly Media.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                           |                                                |   |
| R2: Cathy O'Neil and Rachel Schutt, Doing Data Science, O'Reilly Media.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                           |                                                |   |
| R3: Hadley Wickham and Garrett Grolemund, R for Data Science, O'Reilly Media.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                           |                                                |   |
| E-Resources / Web Resources                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                           |                                                |   |
| <ol style="list-style-type: none"><li>1. <a href="https://pandas.pydata.org">https://pandas.pydata.org</a></li><li>2. <a href="https://matplotlib.org">https://matplotlib.org</a></li><li>3. <a href="https://seaborn.pydata.org">https://seaborn.pydata.org</a></li><li>4. <a href="https://www.kaggle.com/learn">https://www.kaggle.com/learn</a></li><li>5. <a href="https://plotly.com/python/">https://plotly.com/python/</a></li></ol>                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                           |                                                |   |

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| Course Code:<br>ADS2008                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Course Name: Exploratory Data Analysis<br>Lab<br>Type of Course: Lab Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | L- T-P- C | 0-0-2-1 |
| Version No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |         |
| NCrF Level-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 5.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |         |
| Course Pre-requisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |         |
| Co-requisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | ADS2107                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |         |
| Anti-requisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |         |
| Course Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | This laboratory course focuses on hands-on implementation of exploratory data analysis techniques using Python. It covers data preprocessing, statistical analysis, visualization, and pattern discovery. Students will work with real-world datasets to identify trends, relationships, and anomalies, supporting data-driven decision making.                                                                                                                                                                                                                                                                   |           |         |
| Course Objective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | This course introduces practical techniques for exploring, analyzing, and visualizing datasets using Python. It aims to enhance students' ability to extract meaningful insights from data through experiential learning.                                                                                                                                                                                                                                                                                                                                                                                         |           |         |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>On successful completion of the course the students shall be able to:</b><br><b>CO1:</b> Recall fundamental concepts of exploratory data analysis [Level 2- Understand] and Python tools.<br><b>CO2:</b> Explain data preprocessing and visualization techniques. [Level 2 – Understand]<br><b>CO3:</b> Apply statistical and visualization methods using Python [Level 3 – Apply] libraries.<br><b>CO4:</b> Analyze datasets to identify patterns, relationships, and [Level 3 – Analyze] anomalies.<br><b>CO5:</b> Analyze data insights and present findings using [Level 4 – Analyze] visualization tools. |           |         |
| Course Content:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |         |
| <ul style="list-style-type: none"><li>• <b>Experiment 1: Introduction to EDA using Python</b><br/>Level 1: Understand the basics of exploratory data analysis and load datasets using pandas. Explore dataset structure, features, and data types.</li><li>• <b>Experiment 2: Descriptive Statistics</b><br/>Level 1: Compute statistical measures such as mean, median, mode, variance, and standard deviation.</li><li>• <b>Experiment 3: Basic Data Visualization</b><br/>Level 1: Create bar charts, line charts, and pie charts using Matplotlib to visualize data.</li><li>• <b>Experiment 4: Handling Missing Data</b><br/>Level 1: Identify and handle missing values using techniques such as deletion and imputation.</li><li>• <b>Experiment 5: Outlier Detection</b><br/>Level 1: Detect outliers using box plots and statistical methods like IQR.</li><li>• <b>Experiment 6: Data Transformation and Scaling</b><br/>Level 1: Perform normalization and standardization of datasets.</li><li>• <b>Experiment 7: Data Wrangling using Pandas</b><br/>Level 1: Perform filtering, grouping, merging, and reshaping operations.</li><li>• <b>Experiment 8: Histogram and Distribution Analysis</b><br/>Level 1: Plot histograms and analyze data distribution patterns.</li><li>• <b>Experiment 9: Correlation Analysis</b><br/>Level 1: Compute correlation matrix and visualize using heatmaps.</li><li>• <b>Experiment 10: Scatter Plots and Pair Plots</b><br/>Level 1: Analyze relationships between variables using scatter plots and pair plots.</li></ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |         |

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| <ul style="list-style-type: none"> <li>• <b>Experiment 11: Multivariate Visualization</b><br/>Level 1: Perform multivariate analysis using advanced visualization techniques.</li> <li>• <b>Experiment 12: Hypothesis Testing Basics</b><br/>Level 1: Apply simple hypothesis testing techniques to datasets.</li> <li>• <b>Experiment 13: Time Series Data Analysis</b><br/>Level 1: Analyze trends in time-based datasets using line plots.</li> </ul> |                                             |
| <ul style="list-style-type: none"> <li>• <b>Experiment 14: Dimensionality Reduction (PCA – Basic)</b><br/>Level 1: Apply PCA to reduce dataset dimensions and visualize results.</li> <li>• <b>Experiment 15: Mini Project – End-to-End EDA</b><br/>Level 1: Perform complete exploratory data analysis on a real-world dataset including preprocessing, visualization, and insights.</li> </ul>                                                         |                                             |
| <b>Targeted Applications &amp; Tools:</b>                                                                                                                                                                                                                                                                                                                                                                                                                |                                             |
| Python (NumPy, pandas)                                                                                                                                                                                                                                                                                                                                                                                                                                   | Data cleaning, preprocessing, and analysis. |
| Matplotlib & Seaborn                                                                                                                                                                                                                                                                                                                                                                                                                                     | Visualization and statistical plotting      |
| Jupyter Notebook / Google Colab                                                                                                                                                                                                                                                                                                                                                                                                                          | Interactive data analysis environment       |
| Plotly                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Interactive visualization dashboards        |
| <b>Skill-Building Activities through Experiential Learning:</b>                                                                                                                                                                                                                                                                                                                                                                                          |                                             |
| • Data Cleaning and Preprocessing<br>Students handle missing values, outliers, and inconsistencies using Python                                                                                                                                                                                                                                                                                                                                          |                                             |
| • Statistical Analysis<br>Learners apply descriptive statistics to understand data patterns                                                                                                                                                                                                                                                                                                                                                              |                                             |
| • Visualization and Pattern Discovery<br>Students create various plots to identify trends and relationships                                                                                                                                                                                                                                                                                                                                              |                                             |
| • Case Study-Based Analysis<br>Learners work with real-world datasets to generate insights                                                                                                                                                                                                                                                                                                                                                               |                                             |
| <b>Text Book</b>                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                             |
| T1: Wes McKinney, <i>Python for Data Analysis</i> , O'Reilly Media                                                                                                                                                                                                                                                                                                                                                                                       |                                             |
| T2: John Tukey, <i>Exploratory Data Analysis</i> , Addison-Wesley                                                                                                                                                                                                                                                                                                                                                                                        |                                             |
| <b>References</b>                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                             |
| R1: Jake VanderPlas, <i>Python Data Science Handbook</i> , O'Reilly                                                                                                                                                                                                                                                                                                                                                                                      |                                             |
| R2: Cathy O'Neil, <i>Doing Data Science</i> , O'Reilly                                                                                                                                                                                                                                                                                                                                                                                                   |                                             |
| R3: Hadley Wickham, <i>R for Data Science</i> , O'Reilly                                                                                                                                                                                                                                                                                                                                                                                                 |                                             |
| <b>E-Resources/Web Resources</b>                                                                                                                                                                                                                                                                                                                                                                                                                         |                                             |
| <ol style="list-style-type: none"> <li>1. <a href="https://pandas.pydata.org">https://pandas.pydata.org</a></li> <li>2. <a href="https://matplotlib.org">https://matplotlib.org</a></li> <li>3. <a href="https://seaborn.pydata.org">https://seaborn.pydata.org</a></li> <li>4. <a href="https://www.kaggle.com">https://www.kaggle.com</a></li> <li>5. <a href="https://plotly.com">https://plotly.com</a></li> </ol>                                   |                                             |

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| Course Code: CSS2264                                                                                                                                                                                                                                                                                                                                                                                                                           | Course Title: Essentials of AI<br>Type of Course: -Theory Course (ESC)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | L-T-P-C                                                               | -0-3        |
| Version No.                                                                                                                                                                                                                                                                                                                                                                                                                                    | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                       |             |
| Course Pre-requisites                                                                                                                                                                                                                                                                                                                                                                                                                          | CSE1500-Computational Thinking Using Python                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                       |             |
| Anti-requisites                                                                                                                                                                                                                                                                                                                                                                                                                                | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                       |             |
| CourseDescription                                                                                                                                                                                                                                                                                                                                                                                                                              | This course introduces foundational and practical Artificial Intelligence using modern platforms, prompt engineering, and engineering application frameworks. It maps real-world routing problems into computational state-spaces to implement classical uninformed (BFS, DFS) and heuristic-guided informed (A*, GBFS) search algorithms. The curriculum explores data engineering pipelines for text tokenization, sentiment pattern recognition, and similarity-driven recommendation workflows. It details the social, ethical, and economic impacts of automation while establishing paradigms for the responsible deployment of technologies. Concluding with integrated mini-projects, the course addresses advanced systems including chatbots, voice assistants, image recognition, and intelligent automation. |                                                                       |             |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                              | This course introduces the fundamentals of Artificial Intelligence, foundational AI tools, prompt engineering, and engineering application frameworks, alongside state-space problem reduction, computational graph mapping, uninformed blind searching, and heuristic-guided informed search algorithms. It explores text dataset preprocessing pipelines, pattern recognition models, similarity metrics, and recommendation system workflows, while addressing the social, ethical, and economic impacts of AI and strategies for the responsible deployment of modern technologies. Additionally, the course covers advanced AI fields including chatbots, voice assistants, image recognition, and intelligent automation through practical case studies and hands-on activities.                                   |                                                                       |             |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                | On successful completion of this course, students will be able to:<br><b>CO1:</b> Explain the Fundamental Concepts and Evolution of AI [Level 2 – Understand]<br><b>CO2:</b> Formulate and Implement Search Strategies for Computational Problem Solving. [Level 3 – Apply]<br><b>CO3:</b> Implement data collection and pre-processing workflows for different data types, and apply performance metrics to systematically evaluate the resulting AI modules. [Level 3 – Apply]<br><b>CO4:</b> Understand the social, ethical, and economic impacts of AI technologies and their influence on society, industries, and employment. [Level 2 – Understand]<br><b>CO5:</b> Analyze advanced AI technologies and their real-world applications through case studies and practical scenarios. [Level 4 – Analyze]           |                                                                       |             |
| CourseContent:                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                       |             |
| Module 1                                                                                                                                                                                                                                                                                                                                                                                                                                       | Introduction to Artificial Intelligence                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Assignment (Fundamentals and Applications of Artificial Intelligence) | 9 Sessions  |
| Topics:<br>Introduction to Artificial Intelligence – Definition and History of AI; Evolution of AI; Goals and Scope of AI; Types of AI – Narrow AI, General AI, Super AI; Applications of AI in Daily Life; AI in Engineering and Industry; Opportunities and Challenges of AI                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                       |             |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                                                                       | Problem Solving & Path Searching                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Practical Assignment (Problem Solving and Path Searching)             | 11 Sessions |
| Topics:<br><b>Finding Answers:</b> Translating a real-world problem into a clean "State-Space" map (e.g., maze navigation, puzzle solving).<br><b>Blind Searching:</b> Uninformed search strategies—how computers search blindly using Breadth-First Search (BFS) and Depth-First Search (DFS).<br><b>Smart Searching:</b> Informed search strategies—introducing "Heuristics" (smart guessing) through A* Search and Greedy Best-First Search |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                       |             |
| Module 3                                                                                                                                                                                                                                                                                                                                                                                                                                       | Data Collection and Pre-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Assignment (Model Evaluation)                                         | 7 Sessions  |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Processing</b>                                         |                                                                                |                   |
| <b>Topics:</b><br>Foundations and the Role of Data in AI Systems-Taxonomy of Engineering Data: Structured, Unstructured, and Semi-Structured Data-Data Collection Methodologies and Acquisition Pipelines-Data Preparation Foundations: Cleaning, Imputation, and Noise Reduction-Data Manipulation, Transformation, and Feature Scaling-Data Augmentation Techniques for Unstructured Data                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                           |                                                                                |                   |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Social, Ethical, and Economic Impacts of AI</b>        | <b>Significant (Social, Ethical, and Economic Impact Analysis of AI)</b>       | <b>9 Sessions</b> |
| <b>Topics:</b><br>Social, Ethical, and Economic Effects of AI – Ethical issues in AI, future challenges and opportunities, impact of AI on the economy and employment, and responsible use of AI technologies.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                           |                                                                                |                   |
| <b>Module 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Advanced AI Technologies and Real-world Case Study</b> | <b>Mini Project / Case Study (AI Technologies and Real-World Applications)</b> | <b>5 Sessions</b> |
| AI Technologies – Voice assistants, image recognition applications, AI chatbots Bias and fairness AI. AI and ML in Healthcare – Disease Prediction, Medical Imaging, Clinical Decision Support Systems, Personalized Healthcare.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                           |                                                                                |                   |
| <b>Targeted Application &amp; Tools that can be used:</b> <ol style="list-style-type: none"> <li><b>Platform:</b><a href="#">Google AI Experiments</a> (Used to explore interactive Narrow AI benchmarks and live neural demonstrations).</li> <li><b>Visualizer:</b><a href="#">Pathfinding Visualizer Repository</a> (Used to simulate, trace, and view running animations of BFS, DFS, and A* search algorithms).</li> <li><b>Model Trainer:</b><a href="#">Teachable Machine by Google</a> (Used to run no-code data pipelines, capture custom audio/image training sets, and deploy pattern recognition blocks).</li> <li><b>Fairness Engine:</b><a href="#">IBM AI Fairness 360</a> (Used to test for algorithmic bias and examine data-driven fairness metrics).</li> <li><b>Ecosystem:</b><a href="#">Hugging Face Models Hub</a> (Used for deploying transformers, text summarization, sentiment analysis, and testing pre-trained NLP chatbots).</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                           |                                                                                |                   |
| <b>Textbook(s):</b> <ol style="list-style-type: none"> <li>Stuart Russell and Peter Norvig, <i>Artificial Intelligence: A Modern Approach</i>, 4th Edition, Pearson Education, 2022.</li> <li>Tom Taulli, <i>Artificial Intelligence Basics: A Non-Technical Introduction</i>, 1st Edition, Apress, 2019.</li> <li>Elaine Rich and Kevin Knight, <i>Artificial Intelligence</i>, 3rd Edition, McGraw Hill Education, 2009.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                           |                                                                                |                   |
| <b>References:</b> <ol style="list-style-type: none"> <li>Melanie Mitchell, <i>Artificial Intelligence: A Guide for Thinking Humans</i>, 1st Edition, Farrar, Straus and Giroux, 2019.</li> <li>Kai-Fu Lee, <i>AI Superpowers</i>, 1st Edition, Houghton Mifflin Harcourt, 2018.</li> <li>Ethem Alpaydin, <i>Introduction to Machine Learning</i>, 4th Edition, MIT Press, 2020</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                           |                                                                                |                   |
| <b>Online Links:</b> <ul style="list-style-type: none"> <li><b>NPTEL Link:</b> * <a href="#">NPTEL: An Introduction to Artificial Intelligence (IIT Delhi Course Vault)</a> – This course explicitly maps to the historical transitions and core architectural definitions of AI.               <ul style="list-style-type: none"> <li><a href="#">NPTEL Video Lectures: History and Scope of AI</a> – Direct access to recorded lectures covering AI history from the 1940s to the present day.</li> </ul> </li> <li><a href="#">Google AI Experiments Ecosystem</a> – A sandbox to experience real-time examples of specialized (Narrow) AI.</li> <li><b>NPTEL Link:</b> * <a href="#">NPTEL: Artificial Intelligence Search Methods for Problem Solving (IIT Madras)</a> – The absolute best resource for this module. Look at the specific lectures on <i>Search: DFS and BFS</i>, <i>Heuristic Search</i>, and <i>The A* Algorithm</i>.</li> <li><a href="#">Pathfinding Visualizer GUI Terminal</a> – An interactive application to execute, track, and witness BFS, DFS, and A* algorithms expanding over obstacles.</li> <li><b>NPTEL Link:</b> <ul style="list-style-type: none"> <li><a href="#">NPTEL: Data Science and Machine Learning Pipelines</a> – Navigate down to the <i>Machine Learning</i>, <i>Data Processing</i>, and <i>Feature Learning Rules</i> chapters to match your syllabus</li> </ul> </li> </ul> |                                                           |                                                                                |                   |

framework.

- [Teachable Machine by Google Platform](#) – A no-code machine learning tool perfect for showing students how changing training datasets alters real-time classification decisions.
- **NPTEL Link:**
  - [NPTEL Plus: AI Essentials and Social Frameworks Hub](#) – Explores systemic oversight, data governance, and training ethics when launching AI products.
- [IBM AI Fairness 360 Open Source Toolkit](#) – A web portal used to mathematically study algorithmic biases and fairness metrics inside data columns.
- **NPTEL Link:**
  - [Swayam Plus / NPTEL: Applied AI & ML Using Python Frameworks](#) – This specialized track hosts practical mini-project guidelines for integrating smart applications across different domains (Healthcare, Agriculture, Cyber).
- [Hugging Face Central Models Repository](#) – Used to pull pre-trained transformers to run sentiment analysis, text summarization, and direct prompt-engineered chatbot interactions.

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|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|----------------|
| <b>Course Code:</b><br>CSS2265 | <b>Course Title: Essentials of AI Lab</b><br><b>Type of Course: Laboratory Course (PCC)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>L-T-P-C</b> | <b>0-0-2-1</b> |
| <b>Version No.</b>             | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                |                |
| <b>Course Pre-requisites</b>   | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                |                |
| <b>Anti-requisites</b>         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                |                |
| <b>CourseDescription</b>       | This course introduces foundational and practical Artificial Intelligence using Python, modern IDEs, and tools like ChatGPT, Gemini, and Hugging Face. Students leverage prompt engineering to benchmark Narrow versus General AI, map structural state-spaces using networkx, and implement classical uninformed (BFS, DFS) and heuristic-guided informed (A*, GBFS) search algorithms. The curriculum covers data engineering pipelines for text tokenization and preprocessing, utilizing pre-trained NLP transformers for sentiment analysis and matplotlib for feature visualization. Students construct intelligent, interactive systems, including rule-based chatbots, content recommendation engines using vector similarity, and microphone-simulated voice assistants. Evaluated via a dual-session framework that pairs conceptual exploration with active problem-solving, the course concludes with an integrated AI mini-project deploying a functional prototype for real-world applications. |                |                |
| <b>Course Objectives</b>       | To develop practical skills in Artificial Intelligence by enabling students to explore foundation AI tools, apply prompt engineering, implement classical uninformed and heuristic-guided search algorithms, design data pipelines for preprocessing text datasets, apply pre-trained NLP models for sentiment analysis, utilize graphical visualization tools for feature distributions, develop interactive chatbot, recommendation, and voice-simulated applications, and construct integrated AI-driven prototypes for real-world engineering problems.                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                |                |
| <b>Course Outcomes</b>         | <p>On successful completion of this course, students will be able to:</p> <p><b>CO1:</b> Apply public AI platforms and structure precise text[Level 3 – Apply] prompts to generate contextual, domain-specific engineering outputs.</p> <p><b>CO2:</b> Implement state-space models, uninformed searches[Level 3 – Apply] (BFS, DFS), and heuristic-guided searches (A*, GBFS) to solve graph routing and navigation problems. .</p> <p><b>CO3:</b> Implement interactive computational models for[Level 3 – Apply] rule-based chatbots, content recommendations, and voice command simulators.</p> <p><b>CO4:</b> Analyze raw datasets and model behaviors using[Level 4 – Analyze] automated text preprocessing, feature distribution matrices, and visual graphing techniques.</p>                                                                                                                                                                                                                         |                |                |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <p><b>CO5:</b> Analyze the behavioral patterns, benchmarking[Level 4 – Analyze] metrics, and structural scope limitations of specialized vs. generalized AI architectures.</p> |
| <p><b>CourseContent:</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                |
| <p><b>Lab Sheet 1: Introduction to AI Platforms</b></p> <ul style="list-style-type: none"> <li>• Context: Understanding the types, scope, and daily life applications of AI.</li> <li>• Problem Statement: Explore different AI platforms such as ChatGPT, Gemini, and Hugging Face. Submit identical query prompts regarding historical AI milestones and daily life use cases, then compare their text outputs based on relevance, speed, and facts.</li> </ul>                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                |
| <p><b>Lab Sheet 2: AI Classification and Benchmark Exploration</b></p> <ul style="list-style-type: none"> <li>• Context: Breaking down the concepts of Narrow AI vs. General AI.</li> <li>• Problem Statement: Interact with zero-code Narrow AI environments (e.g., Quick Draw or Google AI Experiments). Benchmark how a specialized computer vision network operates and write a brief analysis detailing why it cannot perform general-purpose tasks.</li> </ul>                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                |
| <p><b>Lab Sheet 3: State-Space Representation and Graph Mapping</b></p> <ul style="list-style-type: none"> <li>• Context: Translating a real-world problem into a clean "State-Space" map.</li> <li>• Problem Statement: Take a physical layout problem (such as a 2D grid maze or a simple puzzle routing map) and write a Python script using the networkx library to map it out computationally as a structural state-space network of nodes and edges.</li> </ul>                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                |
| <p><b>Lab Sheet 4: Uninformed (Blind) Searching Implementation</b></p> <ul style="list-style-type: none"> <li>• <b>Context:</b> (Using the state-space map designed in Lab 4) — Implementing a layer-by-layer blind search strategy.</li> <li>• <b>Problem Statement:</b> Write a Python program to execute a <b>Breadth-First Search (BFS)</b> algorithm on your graph environment. Given a starting node and a target destination node, use a <b>Queue (FIFO)</b> data structure to explore the graph layer by layer. Display the exact step-by-step node traversal order and the final shortest path found.</li> </ul>                                                                                                                                                     |                                                                                                                                                                                |
| <p><b>Lab Sheet 5: Uninformed (Blind) Searching Implementation</b></p> <ul style="list-style-type: none"> <li>• Context: (Using the state-space map designed in Lab 4) — Implementing a deep-branch blind search strategy.</li> <li>• Problem Statement: Write a Python program to execute a Depth-First Search (DFS) algorithm on your graph environment. Given a starting node and a target destination node, use a Stack (LIFO) data structure to explore deep along each branch before backtracking. Display the exact step-by-step node traversal order and the final path found.</li> </ul>                                                                                                                                                                             |                                                                                                                                                                                |
| <p><b>Lab Sheet 6: Informed (Smart) Searching with Heuristics</b></p> <ul style="list-style-type: none"> <li>• Context: — Introducing Heuristics through A* Search and Greedy Best-First Search.</li> <li>• Problem Statement: Implement the A* Search algorithm on your coordinate-based graph or grid map. Define a straight-line Euclidean distance heuristic to guide the pathfinder and compare its path efficiency and node-expansion count against uninformed blind searches.</li> </ul>                                                                                                                                                                                                                                                                               |                                                                                                                                                                                |
| <p><b>Lab Sheet 7: Informed Search – Greedy Best-First Search (GBFS)</b></p> <ul style="list-style-type: none"> <li>• <b>Objective:</b> To implement a heuristic-guided, smart-guessing optimization algorithm to rapidly navigate towards a target node.</li> <li>• <b>Problem Statement:</b> Write a simple Python program to execute a <b>Greedy Best-First Search (GBFS)</b> pathfinding algorithm across a graph network environment. Given a starting node and a target destination, create a lookup table mapping heuristic values (estimated straight-line distance to the target) for each vertex. At every step, implement a greedy loop that evaluates neighbours and moves directly into the unvisited node that possesses the lowest (best) heuristic</li> </ul> |                                                                                                                                                                                |

score.

#### Lab Sheet 8: Dataset Collection & Preprocessing

- **Context:** Understanding the role of data, types of data, and processing pipelines.
- **Problem Statement:** Collect raw text-based datasets (such as product reviews or short logs from Kaggle). Write a Python script to preprocess the data by performing basic tokenization, lowercase conversion, and removing trivial characters..

**Lab Sheet 9:** Tabular Data Engineering Pipeline: Cleaning, Imputation, Text Parsing, and Feature Scaling of Corrupted Cyber-Physical Streams.

**Lab Sheet 10:** Spatial Engineering Pipelines: Image Noise Mitigation, Gaussian Filtering, and Geometric Data Augmentation.

**Lab Sheet 11:** Foundational Data Pre-Processing: Data Taxonomy, Handling Outliers, Mean Imputation, and Min-Max Feature Scaling. **Lab Sheet 12: AI Chatbot Development**

- **Problem Statement:**

- Develop a rule-based chatbot using Python and integrate contextual AI-generated responses for interactive communication.

**Lab Sheet 13: : Implementing a Hugging Face Pipeline for Automated Plant Disease Diagnostics using Python**

**Lab Sheet 14: Voice Assistant Simulation**

- **Problem Statement:**

- Develop a basic voice assistant using Python speech libraries and implement voice commands for search, greetings, and simple automation tasks.

**Lab Sheet 15: AI Mini Project**

- **Problem Statement:**

- Develop and demonstrate an AI-based application integrating concepts such as NLP, machine learning, chatbot systems, or recommendation systems.

#### Targeted Application & Tools that can be used:

6. ChatGPT, Gemini, Hugging Face, Canva AI, Python
7. Python IDEs like PyCharm-Jupyter Notebook /Google Collab

#### Project work/Assignment: Mention the Type of Project /Assignment proposed for this course

The course is a lab-based course with all the assessments centrally evaluated. Every experiment consists of **two sessions**. The first session involves exploring a solution to the problem. The second session involves solving a particular problem.

#### Textbook(s):

1. Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, 4th Edition, Pearson Education, 2022.
2. Pang-Ning Tan, Michael Steinbach, Anuj Karpatne, and Vipin Kumar, *Introduction to Data Mining*, 2nd Edition, Pearson Education, 2019.
3. Lewis Tunstall, Leandro von Werra, and Thomas Wolf, *Natural Language Processing with Transformers*, Revised Edition, O'Reilly Media, 2022.

#### References:

1. Elaine Rich, Kevin Knight, and Shivashankar B. Nair, *Artificial Intelligence*, 3rd Edition, McGraw Hill Education, 2009.
2. Jake VanderPlas, *Python Data Science Handbook: Essential Tools for Working with Data*, 2nd Edition, O'Reilly Media, 2022.

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| <b>Course Code:</b><br>FIN1002                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Course Title: Essentials of Finance</b><br><b>Type of Course: HSMC</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                  | <b>L-T-P-C</b>         | 3-0-0-3           |
| <b>Version No.</b>                                                                                                                                                                                                                                                                                                                                                                                                                            | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                  |                        |                   |
| <b>Course Pre-requisites</b>                                                                                                                                                                                                                                                                                                                                                                                                                  | This course is designed to be accessible to all students, regardless of their prior financial knowledge.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                  |                        |                   |
| <b>Anti-requisites</b>                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                  |                        |                   |
| <b>Course Description</b>                                                                                                                                                                                                                                                                                                                                                                                                                     | This course is designed to equip students with a <b>foundational understanding of key financial concepts and principles</b> . It will enable them to comprehend the <b>core functions of finance</b> , delve into the intricacies of <b>financial management within organizations</b> , and gain insights into the <b>fundamental aspects of taxation</b> . The course aims to develop students' abilities to <b>interpret financial statements, evaluate investment opportunities, understand capital structure decisions</b> , and navigate the <b>basics of tax implications</b> .                                 |                  |                        |                   |
| <b>Course Objective</b>                                                                                                                                                                                                                                                                                                                                                                                                                       | Upon successful completion of this course, students will be able to: <ul style="list-style-type: none"> <li>• <b>Understand the basic forms of business organization and their financial implications.</b></li> <li>• <b>Understand the fundamental principles and concepts</b> that influence financial decision-making in various contexts.</li> <li>• <b>Analyse and interpret financial statements</b> to assess the financial health and performance of an organization.</li> <li>• <b>Identify income under various heads of income as per Income Tax Act, 1961 and determine the tax liability.</b></li> </ul> |                  |                        |                   |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>List the course outcomes</b><br><b>On successful completion of this course the students shall be able to:</b><br><b>CO1:</b> Understand the basic concepts of finance and financial [Level 2 - markets and organizations.. Understand]<br><b>CO2:</b> Apply and interpret financial information for business [Level 3 - Apply] decision making.<br><b>CO3:</b> Identify various heads of income and deduction under [Level 2 - Income Tax Act, 1961 Understanding]                                                                                                                                                 |                  |                        |                   |
| <b>Course Content:</b>                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                  |                        |                   |
| <b>Module 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Introduction to Finance</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Assignment/ Quiz | Numerical solving Task | <b>0 Sessions</b> |
| <b>Definition and Scope of Finance, Areas of Finance: Corporate Finance, Investments, Financial Institutions, International Finance; Types of Financial Markets: Money Markets vs. Capital Markets, Primary vs. Secondary Markets; Forms of Business Organization and Financial Goals: Shareholder Wealth Maximization vs. Profit Maximization; Understanding Financial Statements: Balance Sheet and Income Statement- Simple Numerical.</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                  |                        |                   |
| <b>Module 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Financial Management</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Assignment/ Quiz | Numerical solving Task | <b>Sessions</b>   |
| <b>Capital Budgeting Decisions: Payback Period, Net Present Value (NPV), Profitability Index (PI), Internal Rate of Return (IRR); Leverage- Basic Numerical; Capital Structure Decisions: Optimal Capital Structure, Trade-off Theory of Capital Structure; Cost of Capital: Equity, Debt, WACC; Dividend Policy: Factors influencing Dividend Policy.</b>                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                  |                        |                   |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Taxation</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Assignment/ Quiz | Numerical solving Task | <b>7 Sessions</b> |
| <b>Principles of a Good Tax System: Equity, Certainty, Convenience, Economy; Direct vs. Indirect Taxes; Residential Status of an Individual- Basic Problems; Heads of Income; Salary, House Property- Basic Numerical; Deductions under Chapter VI-A; Computation of Taxable Income and Tax Liability; E-Filing procedure.</b>                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                  |                        |                   |

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| <b>Targeted Application &amp; Tools that can be used:</b><br>Textbooks, PPT, Spreadsheet Software (e.g., Microsoft Excel), Official Website of Income Tax Department.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
| <b>Project Work/ Assignment:</b><br>1. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.<br><br>2. Case Study: - At the end of the course students will be given a 'real-world' cases like business models of successful companies or tax evasion by reputed companies on which they have to come up with detailed analysis and assessment.                                                                                                                                                                                                                                                                                                                                                                                          |  |
| <b>Text Book(s):</b><br>1. Dr. Vinod K. Singhania & Dr. Monica Singhania. (Latest Assessment Year Edition). <i>Students' Guide to Income Tax including GST</i> . Taxmann Publications.<br>2. Pandey, I. M. (2025). <i>Financial Management</i> . Vikas Publishing House.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |
| <b>Reference Book (s):</b><br>1. Bhole, L.M., & Mahakud, J. (Current Edition). <i>Financial Institutions and Markets: Structure, Growth and Innovations</i> . McGraw Hill Education India.<br>2. Mehrotra, H.C., & Goyal, S.P. (Latest Assessment Year Edition). <i>Income Tax Law &amp; Practice</i> . Sahitya Bhawan Publications.<br>3. Gordon, E., & Natarajan, K. (Current Edition). <i>Financial Markets and Services</i> . Himalaya Publishing House.<br>Online Resources (e-books, notes, ppts, video lectures etc.):<br>1. <a href="https://presidencyuniversity.linways.com">https://presidencyuniversity.linways.com</a><br>2. <a href="https://onlinecourses.nptel.ac.in/noc24_ec01/preview">https://onlinecourses.nptel.ac.in/noc24_ec01/preview</a><br>3. <a href="https://www.incometax.gov.in/iec/foportal/">https://www.incometax.gov.in/iec/foportal/</a> |  |
| Topics relevant to “ <b>SKILL DEVELOPMENT</b> ”: This course is designed to provide practical financial skills through participative learning techniques. Students will engage in performing suitable calculations to determine financial parameters (e.g., time value of money, investment returns, tax liabilities) and analysing financial statements to assess organizational performance and make informed decisions.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |

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| Course Code:<br><b>APT4004</b> | <b>Course Title: Aptitude Training- Intermediate</b><br><br>Type of Course: Practical Only Course                                                               | L- T- P- C | 0-0-2-0 |
| Version No.                    | 1.0                                                                                                                                                             |            |         |
| Course Pre-requisites          | Students should have the basic concepts of Quantitative aptitude along with its applications in real life problems.                                             |            |         |
| Anti-requisites                | NIL                                                                                                                                                             |            |         |
| Course Description             | This is a skill-based training program for the students. This course is designed to enable the students to enhance their skills in Quantitative Aptitude.       |            |         |
| Course Objective               | <b>The objective of the course is to familiarize the learners with the concept of Aptitude and attain Skill Development through Problem Solving techniques.</b> |            |         |

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| Course Out Comes                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <p><b>On successful completion of this course the student shall be able</b></p> <p><b>CO1:</b> Recall all the basic mathematical concepts. [Level 1 - Remember]</p> <p><b>CO2:</b> Identify the principle concept needed in a question. [Level 2 - Understand]</p> <p><b>CO3:</b> Solve the quantitative and logical ability questions with the appropriate concept. [Level 3 - Apply]</p> <p><b>CO4:</b> Analyze the data given in complex problems. for these cos [Level 4 - Analyze] give me level</p> |            |                 |
| Course Content:                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |                 |
| Module 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Quantitative Ability 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Assignment | <b>16 Hours</b> |
| <p>Topics:<br/>Number System, Percentage, Ratio and Proportion, Average, Mixture and Allegation, Time and Work, Profit and Loss</p>                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |                 |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Quantitative Ability 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Assignment | <b>14 Hours</b> |
| <p>Topics:<br/>Time Speed and Distance, Boats and Streams, Simple Interest, Compound Interest, Probability, Permutation and Combination</p>                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |                 |
| <p>Targeted Application &amp; Tools that can be used:<br/>Application area: Placement activities and Competitive examinations. Tools: LMS</p>                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |                 |
| <b>Continuous Evaluation:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |                 |
| CA1 – Online Test CA2 – Online Test CA3 – Online Test Assignment                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |                 |
| <p><b>Text Book:</b></p> <ol style="list-style-type: none"> <li>1. Fast Track Objective by Rajesh Verma</li> <li>2. RS Aggarwal</li> <li>3. Rakesh Yadav</li> </ol> <p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. <a href="http://www.indiabix.com">www.indiabix.com</a></li> <li>2. <a href="http://www.testbook.com">www.testbook.com</a></li> <li>3. <a href="http://www.youtube.com/c/TheAptitudeGuy/videos">www.youtube.com/c/TheAptitudeGuy/videos</a></li> </ol> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |                 |
| <p>Topics relevant to Skill Development: Quantitative aptitude for Skill Development through Problem solving Techniques. This is attained through components mentioned in course handout.</p>                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |                 |

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| <b>Course Code:</b><br>ADS2009 | <b>Course Title:</b> Big Data Technologies<br><b>Type of Course:</b> Program Core/Theory Course | <b>L- T-P- C</b> | 3-0-0-3 |
| <b>Version No.</b>             | 1.0                                                                                             |                  |         |
| <b>NCrF Level-</b>             | 5.0                                                                                             |                  |         |

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| CoursePre-requisites                                                                                                                                                                                                                                                 | DataStructuresandAnalysisofAlgorithms,DatabaseManagementSystems,Data CommunicationandComputerNetworks,ComputationalThinkingusingPython.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                               |            |
| Co-requisites                                                                                                                                                                                                                                                        | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                               |            |
| Anti-requisites                                                                                                                                                                                                                                                      | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                               |            |
| CourseDescription                                                                                                                                                                                                                                                    | Thiscourseprovidesanan-in-depthunderstandingofthetechnologiesandframeworksused forBigData processing, storage, and analytics. It coversthe theoretical foundationsand practical implementations of distributed computing models such as MapReduce and Apache Hadoop, along with modern Big Data toolsand platforms. The course explores techniques for large-scale data processing, including graph analytics, clustering, recommendation systems, and streaming data processing. Students will develop the abilitytodesignscalabledataprocessingpipelinesandanalyzelargedatasetsusing industry-standardBigDatatechnologies.                                                                                                                                                              |                                                               |            |
| CourseObjective                                                                                                                                                                                                                                                      | This course is designed to enhance the learners' <b>EMPLOYABILITY SKILLS</b> by providing <b>experiential learning opportunities</b> in Big Data processing, analytics, and scalablecomputingframeworks.Studentswillgainhands-onexposuretodistributeddata processingtoolssuchas <b>Hadoop,Spark,andKafka</b> ,enablingthemtoanalyzeand managelarge-scaledatasetseffectivelyforreal-world applications                                                                                                                                                                                                                                                                                                                                                                                     |                                                               |            |
| CourseOutcomes                                                                                                                                                                                                                                                       | <b>Onsuccessfulcompletionofthecoursethestudentsshallbeableto:</b><br><b>C01:</b> Explain the concepts, architecture, and challenges of Big [Level 2- Data technologies and distributed computing frameworks. Understand]<br><b>C02:</b> Apply Hadoop, MapReduce, and Apache Spark to process[Level 3 – Apply] and analyze large-scale datasets efficiently.<br><b>C03:</b> Analyze big data mining techniques such as clustering,[Level 4 – classification, and recommendation systems on distributedAnalyze] platforms.<br><b>C04:</b> Analyze streaming data processing techniques and their[Level 4- Analyze] applications in large-scale data systems.<br><b>C05:</b> Analyze scalable big data solutions using distributed[Level 4- Analyze] frameworks for real-world applications. |                                                               |            |
| CourseContent:                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                               |            |
| Module1                                                                                                                                                                                                                                                              | IntroductiontoBig DataandHadoopEcosystem                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Assessment: Assignment (Hadoop Ecosystem Tools / Case Study)  | 9Sessions  |
| Introduction to Big Data – Characteristics (5Vs) – Challenges and applications – Traditional vs Big Data systems – Hadoop ecosystem overview – HDFS architecture – NameNode and DataNode – YARN architecture – Overview of tools: Hive, Pig, HBase, Spark.           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                               |            |
| Module2                                                                                                                                                                                                                                                              | Hadoop Distributed File System and MapReduce                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Assessment: Quiz + Programming Assignment (Hadoop/MapReduce)  | 9Sessions  |
| HDFS storage mechanism – Block storage and replication – File operations and data access – MapReduce programming model – Mapper, Reducer, Combiner, Partitioner – Data flow in MapReduce – Performance and limitations.                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                               |            |
| Module3                                                                                                                                                                                                                                                              | Data Processing with Apache Spark                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Assessment: Assignment (Spark Programming usingPySpark/Scala) | 9 Sessions |
| Introduction to Apache Spark – Spark architecture – Resilient Distributed Datasets (RDDs) – Transformations and actions – Spark SQL and DataFrame APIs – Performance advantages of Spark – Comparison of Spark and Hadoop MapReduce – Basic optimization techniques. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                               |            |

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| Module4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Big Data Analytics Algorithms | Assessment: Programming Assignment (MLlib / Data Mining Algorithms)                                  | 9Sessions |
| Frequent itemset mining (Apriori, PCY algorithms) – Market basket analysis – Clustering techniques (K-Means, Locality-Sensitive Hashing) – Classification techniques (Naïve Bayes, Decision Trees) – Dimensionality reduction (SVD, PCA) – Applications in big data analytics.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                               |                                                                                                      |           |
| Module5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Advanced Topics in Big Data   | Assessment: Mini Project (Kafka/Spark Streaming/Recommendation System)                               | 9Sessions |
| Graph processing and web mining – PageRank algorithm – Community detection and link prediction – Recommendation systems (user-based and item-based) – Introduction to streaming data – Real-time analytics using Kafka/Spark – Case studies (Twitter, Netflix pipelines).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                               |                                                                                                      |           |
| Targeted Applications&Tools:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                               |                                                                                                      |           |
| Python/Java                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                               | Programming languages used for implementing data processing algorithms and distributed applications. |           |
| ApacheHadoop                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                               | Framework for distributed storage and processing of large datasets.                                  |           |
| ApacheSpark                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                               | Fast cluster computing framework for big data analytics.                                             |           |
| Hive & Pig                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                               | Querying and scripting tools for data analysis in Hadoop.                                            |           |
| ApacheKafka/Flink                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                               | Real-time streaming data processing                                                                  |           |
| HDFS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                               | Distributed file system for storing large datasets                                                   |           |
| MongoDB/Cassandra                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                               | NoSQL databases for scalable storage                                                                 |           |
| Jupyter Notebook/Docker                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                               | Development, experimentation, and deployment environments                                            |           |
| Cloud Platforms(AWS,GCP, Azure)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                               | Scalable infrastructure for big data processing                                                      |           |
| Skill-Building Activities through Experiential Learning:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                               |                                                                                                      |           |
| <ul style="list-style-type: none"><li>• Distributed Data Processing using Hadoop<br/>Students implement MapReduce programs to process large datasets. They learn to design Mapper, Reducer, Combiner, and Partitioner functions and understand how distributed processing improves scalability and performance.</li><li>• Big Data Analytics with Apache Spark<br/>Learners use Spark RDDs, DataFrames, and Spark SQL to perform large-scaled data analysis. They compare Spark with traditional Hadoop MapReduce to understand improvements in speed and memory-based processing.</li><li>• Real-Time Streaming Data Processing<br/>Students analyze streaming data using Kafka and Spark Streaming, implementing simple real-time analytics pipelines such as social media sentiment analysis or IoT sensor monitoring.</li><li>• Recommendation Systems and Graph Analytics<br/>Students develop collaborative filtering recommendation systems and explore graph analytics techniques like PageRank and community detection using large dataset.</li></ul> |                               |                                                                                                      |           |
| Textbooks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                               |                                                                                                      |           |
| T1: Mining of Massive Datasets, Jure Leskovec, Anand Rajaraman, Jeffrey D. Ullman, Cambridge University Press, 3rd Edition, 2020 (Latest)<br>T2: Venkat Ankam, Big Data Analytics, Springer International Publishing, 2016.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                               |                                                                                                      |           |
| References                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                               |                                                                                                      |           |
| R1: Jimmy Lin and Chris Dyer, Data-Intensive Text Processing with MapReduce, Morgan & Claypool, 2010.<br>R2: Big Data: Principles and Best Practices of Scalable Real-Time Data Systems, Nathan Marz and James Warren, Manning Publications, 2015.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                               |                                                                                                      |           |

**E-Resources/WebResources**

1. <https://nptel.ac.in/courses/106104189>
2. <https://nptel.ac.in/courses/106106142>
3. <https://nptel.ac.in/courses/106106213>
4. <https://spark.apache.org/documentation.html>
5. <https://hadoop.apache.org/docs>

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| Course Code:<br>CSD1705                                                                                                                                                                                                                                                                        | Course Name: Cloud Computing for Data Science<br>Type of Course: Theory Course                                                                                                                                                                                                                                                                            | L- T-P- C | 2-0-0-2    |
| Version No.                                                                                                                                                                                                                                                                                    | 1.0                                                                                                                                                                                                                                                                                                                                                       |           |            |
| NCrF Level-                                                                                                                                                                                                                                                                                    | 5.0                                                                                                                                                                                                                                                                                                                                                       |           |            |
| Course Pre-requisites                                                                                                                                                                                                                                                                          | NIL                                                                                                                                                                                                                                                                                                                                                       |           |            |
| Co-requisites                                                                                                                                                                                                                                                                                  | CSD1706                                                                                                                                                                                                                                                                                                                                                   |           |            |
| Anti-requisites                                                                                                                                                                                                                                                                                | NIL                                                                                                                                                                                                                                                                                                                                                       |           |            |
| Course Description                                                                                                                                                                                                                                                                             | Cloud Computing for Data Science introduces learners to the integration of cloud platforms with data science workflows. The course covers cloud storage, data pipelines, machine learning deployment, and real-time analytics using AWS, Azure, and GCP. Students will gain hands-on experience with industry tools and scalable cloud services.          |           |            |
| Course Objective                                                                                                                                                                                                                                                                               | The objective of the course is skill development of student by using Learning techniques                                                                                                                                                                                                                                                                  |           |            |
| Course Outcomes                                                                                                                                                                                                                                                                                | On successful completion of the course the students shall be able to:<br>CO1: Understand the core concepts of cloud computing.<br>CO2: Learn to use cloud platforms for storing, processing, and analyzing data.<br>CO3:Implement data science workflows on cloud environments.<br>CO4: Master scalable machine learning and big data tools on the cloud. |           |            |
| Course Content:                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                           |           |            |
| Module 1                                                                                                                                                                                                                                                                                       | Fundamentals of Cloud Computing                                                                                                                                                                                                                                                                                                                           |           | 7 Sessions |
| Topics:<br>Overview of Cloud Computing, Service Models: IaaS, PaaS, SaaS, Deployment Models: Public, Private, Hybrid, Community, Virtualization and Containers (Docker, Kubernetes basics);<br>Introduction to AWS, Azure, and Google Cloud Platform , Security and Compliance in the Cloud    |                                                                                                                                                                                                                                                                                                                                                           |           |            |
| Module 2                                                                                                                                                                                                                                                                                       | Cloud Storage & Data Engineering                                                                                                                                                                                                                                                                                                                          |           | 8 Sessions |
| Topics:<br>Cloud Storage Services (S3, Google Cloud Storage, Azure Blob);Data Lake vs. Data Warehouse; ETL Pipelines in the Cloud (AWS Glue, Dataflow, Azure Data Factory); Data Migration & Ingestion Tools;Distributed Computing with Hadoop and Spark on Cloud;Cost Optimization Techniques |                                                                                                                                                                                                                                                                                                                                                           |           |            |
| Module 3                                                                                                                                                                                                                                                                                       | Machine Learning and Analytics on the Cloud                                                                                                                                                                                                                                                                                                               |           | 8 Sessions |
| Topics:                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                           |           |            |

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| Cloud ML Tools (AWS SageMaker, Azure ML, Google Vertex AI); End-to-End ML Pipelines on the Cloud; Model Deployment and Monitoring; AutoML and MLOps; Integrating Notebooks (Jupyter, Colab) with Cloud Environments; Real-Time Analytics with BigQuery, Redshift                                                                                                                                                                                                                                        |                      |                           |            |
| Module 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Time Series Analysis | Discussion & Presentation | 7 Sessions |
| Topics:<br>Introduction to Serverless Computing (AWS Lambda, Azure Functions) ; Cloud-Native Data Science Tools , Generative AI and LLMs in Cloud , Edge Computing and IoT Integration                                                                                                                                                                                                                                                                                                                  |                      |                           |            |
| <b>Text Book</b><br>T1."Cloud Computing: Concepts and Technology" by Thomas Erl, Zaigham Mahmood, and Ricardo Puttini – 2nd Edition (2023)<br>T2.A foundational text covering updated cloud architectures, platforms, and security.                                                                                                                                                                                                                                                                     |                      |                           |            |
| <b>References</b><br><b>R1:</b> Data Science on the Google Cloud Platform: Implementing End-to-End Real-Time Data Pipelines" by Valliappa Lakshmanan (2023), Hands-on guide to building scalable data science projects on Google Cloud<br><b>R2:</b> Machine Learning Engineering with Python: Deploy and Scale ML Models on AWS, Azure, and GCP" by Andrew P. McMahon (2024), Recent guide on using cloud platforms for production-level ML systems.                                                   |                      |                           |            |
| <b>E-Resources/Web Resources</b> <ol style="list-style-type: none"> <li>1. <a href="https://aws.amazon.com/training/">https://aws.amazon.com/training/</a></li> <li>2. <a href="https://learn.microsoft.com/en-us/training/azure/">https://learn.microsoft.com/en-us/training/azure/</a></li> <li>3. <a href="https://www.cloudskillsboost.google/">https://www.cloudskillsboost.google/</a></li> <li>4. <a href="https://www.ibm.com/training/cloud">https://www.ibm.com/training/cloud</a></li> </ol> |                      |                           |            |

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| Course Code:<br>CSD1706 | Course Name: Cloud Computing for Data Science<br>Type of Course: Theory Course                                                                                                                                                                                                                                                                   | L- T-P- C | 0-0-2-1 |
| Version No.             | 1.0                                                                                                                                                                                                                                                                                                                                              |           |         |
| Course Pre-requisites   | NIL                                                                                                                                                                                                                                                                                                                                              |           |         |
| Co-requisites           | CSD1706                                                                                                                                                                                                                                                                                                                                          |           |         |
| Anti-requisites         | NIL                                                                                                                                                                                                                                                                                                                                              |           |         |
| Course Description      | Cloud Computing for Data Science introduces learners to the integration of cloud platforms with data science workflows. The course covers cloud storage, data pipelines, machine learning deployment, and real-time analytics using AWS, Azure, and GCP. Students will gain hands-on experience with industry tools and scalable cloud services. |           |         |
| Course Objective        | The objective of the course is skill development of student by using Learning techniques                                                                                                                                                                                                                                                         |           |         |

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| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                | On successful completion of the course the students shall be able to:<br>CO1: Understand the core concepts of cloud computing.<br>CO2: Learn to use cloud platforms for storing, processing, and analyzing data.<br>CO3:Implement data science workflows on cloud environments.<br>CO4: Master scalable machine learning and big data tools on the cloud. |                           |            |
| Course Content:                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                           |                           |            |
| Module 1                                                                                                                                                                                                                                                                                                                                                                                                                                       | Fundamentals of Cloud Computing                                                                                                                                                                                                                                                                                                                           |                           | 7 Sessions |
| Topics:<br>Overview of Cloud Computing, Service Models: IaaS, PaaS, SaaS, Deployment Models: Public, Private, Hybrid, Community, Virtualization and Containers (Docker, Kubernetes basics);<br>Introduction to AWS, Azure, and Google Cloud Platform , Security and Compliance in the Cloud                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                           |                           |            |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                                                                       | Cloud Storage & Data Engineering                                                                                                                                                                                                                                                                                                                          |                           | 8 Sessions |
| Topics:<br>Cloud Storage Services (S3, Google Cloud Storage, Azure Blob);Data Lake vs. Data Warehouse; ETL Pipelines in the Cloud (AWS Glue, Dataflow, Azure Data Factory); Data Migration & Ingestion Tools;Distributed Computing with Hadoop and Spark on Cloud;Cost Optimization Techniques                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                           |                           |            |
| Module 3                                                                                                                                                                                                                                                                                                                                                                                                                                       | Machine Learning and Analytics on the Cloud                                                                                                                                                                                                                                                                                                               |                           | 8 Sessions |
| Topics:<br>Cloud ML Tools (AWS SageMaker, Azure ML, Google Vertex AI); End-to-End ML Pipelines on the Cloud; Model Deployment and Monitoring; AutoML and MLOps; Integrating Notebooks (Jupyter, Colab) with Cloud Environments; Real-Time Analytics with BigQuery, Redshift                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                           |                           |            |
| Module 4                                                                                                                                                                                                                                                                                                                                                                                                                                       | Time Series Analysis                                                                                                                                                                                                                                                                                                                                      | Discussion & Presentation | 7 Sessions |
| Topics:<br>Introduction to Serverless Computing (AWS Lambda, Azure Functions) ; Cloud-Native Data Science Tools , Generative AI and LLMs in Cloud , Edge Computing and IoT Integration                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                           |                           |            |
| Text Book<br>T1."Cloud Computing: Concepts and Technology" by Thomas Erl, Zaigham Mahmood, and Ricardo Puttini – 2nd Edition (2023)<br>T2.A foundational text covering updated cloud architectures, platforms, and security.                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                           |                           |            |
| References<br><b>R1:</b> Data Science on the Google Cloud Platform: Implementing End-to-End Real-Time Data Pipelines" by Valliappa Lakshmanan (2023), Hands-on guide to building scalable data science projects on Google Cloud<br><b>R2:</b> Machine Learning Engineering with Python: Deploy and Scale ML Models on AWS, Azure, and GCP" by Andrew P. McMahon (2024), Recent guide on using cloud platforms for production-level ML systems. |                                                                                                                                                                                                                                                                                                                                                           |                           |            |
| E-Resources/Web Resources<br>1. <a href="https://aws.amazon.com/training/">https://aws.amazon.com/training/</a><br>2. <a href="https://learn.microsoft.com/en-us/training/azure/">https://learn.microsoft.com/en-us/training/azure/</a><br>3. <a href="https://www.cloudskillsboost.google/">https://www.cloudskillsboost.google/</a><br>4. <a href="https://www.ibm.com/training/cloud">https://www.ibm.com/training/cloud</a>                |                                                                                                                                                                                                                                                                                                                                                           |                           |            |

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| Course Code:<br>CSD2021                                                                                                                                                                                                                                                                                                                                                       | Course Name: Machine Learning for<br>Intelligent Data Science<br>Type of Course: Theory Course                                                                                                                                                                                                                                                                                                                                                                                      | L- T-P- C                       | 3-0-0-3     |
| Version No.                                                                                                                                                                                                                                                                                                                                                                   | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                 |             |
| Course Pre-requisites                                                                                                                                                                                                                                                                                                                                                         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                 |             |
| Co-requisites                                                                                                                                                                                                                                                                                                                                                                 | CSD2024- Machine Learning for Intelligent Data Science Lab                                                                                                                                                                                                                                                                                                                                                                                                                          |                                 |             |
| Anti-requisites                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                 |             |
| Course Description                                                                                                                                                                                                                                                                                                                                                            | This course introduces the concepts, techniques, and applications of Machine Learning for intelligent data-driven decision making. It focuses on supervised, unsupervised, and ensemble learning methods along with model evaluation and optimization techniques. Students will learn how to build intelligent systems capable of extracting patterns, predicting outcomes, and supporting real-world data science applications using modern machine learning frameworks and tools. |                                 |             |
| Course Objective                                                                                                                                                                                                                                                                                                                                                              | <ul style="list-style-type: none"> <li>To understand the fundamentals of machine learning and intelligent data science concepts.</li> <li>To develop predictive models using supervised and unsupervised learning techniques.</li> <li>To apply machine learning algorithms for classification, regression, clustering, and pattern recognition tasks.</li> <li>To evaluate and optimize machine learning models for real-world intelligent applications.</li> </ul>                |                                 |             |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                               | <b>On successful completion of the course the students shall be able to:</b>                                                                                                                                                                                                                                                                                                                                                                                                        |                                 |             |
|                                                                                                                                                                                                                                                                                                                                                                               | CO1: Understand the fundamentals of machine learning algorithms and intelligent data science workflows.                                                                                                                                                                                                                                                                                                                                                                             | [Level 2-Understand]            |             |
|                                                                                                                                                                                                                                                                                                                                                                               | CO2: Apply supervised learning techniques for predictive analytics and classification tasks.                                                                                                                                                                                                                                                                                                                                                                                        | [Level 3-Apply]                 |             |
|                                                                                                                                                                                                                                                                                                                                                                               | CO3: Implement unsupervised and ensemble learning methods for pattern discovery and intelligent decision-making.                                                                                                                                                                                                                                                                                                                                                                    | [Level 4-Analyze]               |             |
|                                                                                                                                                                                                                                                                                                                                                                               | CO4: Evaluate machine learning models and interpret their performance for real-world applications.                                                                                                                                                                                                                                                                                                                                                                                  | [Level 5-Evaluate]              |             |
| Course Content:                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                 |             |
| Module 1                                                                                                                                                                                                                                                                                                                                                                      | Introduction to Machine Learning and Intelligent Data Science                                                                                                                                                                                                                                                                                                                                                                                                                       | Assessment: Preprocessing       | 10 Sessions |
| Topics:<br>Introduction to Artificial Intelligence, Machine Learning, and Data Science<br>Types of Machine Learning<br>Machine Learning workflow<br>Data preprocessing and feature engineering<br>Training, validation, and testing datasets<br>Evaluation metrics and model selection<br>Introduction to Python libraries for ML<br>Applications of intelligent data science |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                 |             |
| Module 2                                                                                                                                                                                                                                                                                                                                                                      | Supervised Learning Techniques                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Assessment: Supervised Learning | 11 Sessions |

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| Topics:<br>Regression and Classification concepts<br>Linear Regression<br>Logistic Regression<br>Decision Trees<br>Naïve Bayes Classifier<br>Support Vector Machines (SVM)<br>K-Nearest Neighbors (KNN)<br>Performance evaluation metrics<br>Overfitting and underfitting                                                                                                  |                                                        |                                                                                                  |             |
| Module 3                                                                                                                                                                                                                                                                                                                                                                   | Unsupervised and Ensemble Learning                     | Assessment: Clustering                                                                           | 12 Sessions |
| Topics:<br>Clustering concepts and applications<br>K-Means Clustering<br>Hierarchical Clustering<br>Dimensionality Reduction<br>Principal Component Analysis (PCA)<br>Association Rule Mining<br>Ensemble Learning concepts<br>Random Forest<br>Boosting and Bagging techniques                                                                                            |                                                        |                                                                                                  |             |
| Module 4                                                                                                                                                                                                                                                                                                                                                                   | Advanced Machine Learning and Intelligent Applications | Assessment: Intelligent Applications                                                             | 12 Sessions |
| Topics:<br>Introduction to Deep Learning<br>Neural Networks fundamentals<br>Model optimization techniques<br>Cross-validation and hyperparameter tuning<br>Explainable AI (XAI) basics<br>Intelligent recommendation systems<br>Time series forecasting<br>Real-world case studies in healthcare, finance, and smart systems<br>Ethical considerations in Machine Learning |                                                        |                                                                                                  |             |
| Targeted Applications & Tools:                                                                                                                                                                                                                                                                                                                                             |                                                        |                                                                                                  |             |
| Python                                                                                                                                                                                                                                                                                                                                                                     |                                                        | Programming language widely used for machine learning and intelligent data science applications. |             |
| Jupyter Notebook                                                                                                                                                                                                                                                                                                                                                           |                                                        | Interactive environment for coding, visualization, and machine learning experimentation.         |             |
| TensorFlow                                                                                                                                                                                                                                                                                                                                                                 |                                                        | Open-source deep learning framework used for building intelligent AI models.                     |             |
| Scikit-learn                                                                                                                                                                                                                                                                                                                                                               |                                                        | Python library used for implementing machine learning algorithms and model evaluation.           |             |
| Text Book<br>T1. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow – O'Reilly Media.<br>T2. Machine Learning – McGraw Hill Education.<br>T3. Pattern Recognition and Machine Learning – Springer.                                                                                                                                                         |                                                        |                                                                                                  |             |
| References<br>R1. Introduction to Machine Learning with Python – O'Reilly Media.<br>R2. Deep Learning – MIT Press.<br>R3. Data Mining Concepts and Techniques – Morgan Kaufmann.                                                                                                                                                                                           |                                                        |                                                                                                  |             |

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| R4. Artificial Intelligence: A Modern Approach – Pearson..                                                                                                                                                                                 |
| E-Resources/Web Resources<br>1.Scikit-learn Documentation<br>2.TensorFlow Official Documentation<br>3.Kaggle Machine Learning Resources<br>4.Coursera Machine Learning Courses<br>4.Google AI Learning Resources<br>5.Towards Data Science |

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| Course Code:<br>CSD2024                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Course Name: Machine Learning for Intelligent Data Science Lab<br>Type of Course: Laboratory Course                                                                                                                                                                                                                                                                                                                                                     | L- T-P- C           | 0-0-2-1 |
| Version No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                     |         |
| Course Pre-requisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                     |         |
| Co-requisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | CSD2021- Machine Learning for Intelligent Data Science                                                                                                                                                                                                                                                                                                                                                                                                  |                     |         |
| Anti-requisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                     |         |
| Course Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | This laboratory course provides practical exposure to machine learning techniques and intelligent data science applications using modern tools and frameworks. Students will learn to preprocess datasets, implement supervised and unsupervised learning algorithms, evaluate predictive models, and develop intelligent analytical solutions for real-world applications through hands-on experiments and mini-projects.                              |                     |         |
| Course Objective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <ul style="list-style-type: none"><li>• To provide practical knowledge of machine learning workflows and intelligent data science techniques.</li><li>• To implement supervised and unsupervised learning algorithms using Python libraries.</li><li>• To perform model evaluation, optimization, and visualization of analytical results.</li><li>• To develop intelligent predictive solutions using machine learning frameworks and tools.</li></ul> |                     |         |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>On successful completion of the course the students shall be able to:</b>                                                                                                                                                                                                                                                                                                                                                                            |                     |         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>C01:</b> Implement machine learning workflows and data preprocessing techniques using Python tools.                                                                                                                                                                                                                                                                                                                                                  | [Level 3 – Apply]   |         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>C02:</b> Develop supervised learning models for prediction and classification tasks.                                                                                                                                                                                                                                                                                                                                                                 | [Level 4 – Analyze] |         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>C03:</b> Apply clustering, dimensionality reduction, and ensemble learning methods for intelligent analytics.                                                                                                                                                                                                                                                                                                                                        | [Level 4 – Analyze] |         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>C04:</b> Evaluate and optimize machine learning models for real-world intelligent data science applications.                                                                                                                                                                                                                                                                                                                                         | [Level 5-Evaluate]  |         |
| Course Content:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                     |         |
| <b>List of Laboratory Tasks:</b><br>Experiment 1: Installation and setup of Python, Jupyter Notebook, and required ML libraries<br>Experiment 2: Perform data preprocessing, cleaning, and handling missing values<br>Experiment 3: Implement feature scaling and normalization techniques<br>Experiment 4: Perform Exploratory Data Analysis (EDA) and data visualization<br>Experiment 5: Implement Linear Regression for predictive analysis<br>Experiment 6: Build Logistic Regression models for classification<br>Experiment 7: Implement Decision Tree and Random Forest algorithms<br>Experiment 8: Apply K-Nearest Neighbors (KNN) classification |                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                     |         |

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| Experiment 9: Perform Support Vector Machine (SVM) classification                                                                                                                                                                                                                                   |                                                                                                        |
| Experiment 10: Evaluate models using confusion matrix, accuracy, precision, recall, and F1-score                                                                                                                                                                                                    |                                                                                                        |
| Experiment 11: Apply K-Means clustering on real-world datasets                                                                                                                                                                                                                                      |                                                                                                        |
| Experiment 12: Perform Hierarchical Clustering and cluster visualization                                                                                                                                                                                                                            |                                                                                                        |
| Experiment 13: Implement Principal Component Analysis (PCA) for dimensionality reduction                                                                                                                                                                                                            |                                                                                                        |
| Experiment 14: Perform hyperparameter tuning and cross-validation                                                                                                                                                                                                                                   |                                                                                                        |
| Experiment 15: Mini Project: Intelligent predictive analytics using machine learning techniques                                                                                                                                                                                                     |                                                                                                        |
| Targeted Applications & Tools:                                                                                                                                                                                                                                                                      |                                                                                                        |
| Python                                                                                                                                                                                                                                                                                              | Programming language used for implementing machine learning and intelligent data science applications. |
| Jupyter Notebook                                                                                                                                                                                                                                                                                    | Interactive environment used for coding, visualization, and experimentation.                           |
| Scikit-learn                                                                                                                                                                                                                                                                                        | Python library used for machine learning model implementation and evaluation.                          |
| TensorFlow                                                                                                                                                                                                                                                                                          | Deep learning framework used for building intelligent AI and neural network models.                    |
| Text Book                                                                                                                                                                                                                                                                                           |                                                                                                        |
| T1. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow – O'Reilly Media.                                                                                                                                                                                                            |                                                                                                        |
| T2. Introduction to Machine Learning with Python – O'Reilly Media.                                                                                                                                                                                                                                  |                                                                                                        |
| T3. Machine Learning – McGraw Hill Education.                                                                                                                                                                                                                                                       |                                                                                                        |
| References                                                                                                                                                                                                                                                                                          |                                                                                                        |
| R1. Pattern Recognition and Machine Learning – Springer.                                                                                                                                                                                                                                            |                                                                                                        |
| R2. Deep Learning – MIT Press.                                                                                                                                                                                                                                                                      |                                                                                                        |
| R3. Data Mining Concepts and Techniques – Morgan Kaufmann.                                                                                                                                                                                                                                          |                                                                                                        |
| R4. Python Machine Learning – Packt Publishing.                                                                                                                                                                                                                                                     |                                                                                                        |
| E-Resources/Web Resources                                                                                                                                                                                                                                                                           |                                                                                                        |
| <ol style="list-style-type: none"> <li>1. Scikit-learn Documentation</li> <li>2. TensorFlow Official Documentation</li> <li>3. Kaggle Machine Learning Resources</li> <li>4. Google AI Learning Resources</li> <li>5. Coursera Machine Learning Courses</li> <li>6. Towards Data Science</li> </ol> |                                                                                                        |

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| Course Code:<br>CSS2269 | Course Name: Operating Systems<br>Type of Course: Theory Course | L- T-P- C | 3-0-0-3 |
| Version No.             | 1.0                                                             |           |         |
| Course<br>requisites    | Pre-                                                            | NIL       |         |
| Co-requisites           | CAI2501                                                         |           |         |
| Anti-requisites         | NIL                                                             |           |         |

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| Course Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | This course introduces the concepts of Operating Systems operations, Operating System structure and its design and implementation. It covers the Operating Systems internal algorithms such as process scheduling, synchronization, deadlocks detection and recovery and memory management. The course also enhances the problem solving, systems programming ability and case studies.                                                                                                                                                                                                                            |                                                              |             |
| Course Objective                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | To develop a comprehensive understanding of operating system principles by enabling students to analyze process management and scheduling algorithms, explore memory and virtual memory management, examine file systems and storage organization and evaluate synchronization mechanisms and deadlock handling techniques.                                                                                                                                                                                                                                                                                        |                                                              |             |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>On successful completion of the course the students shall be able to:</b><br><br><b>CO1:</b> Explain the fundamental concepts of operating systems and[Level 2 - relevant case studies. Understand]<br><b>CO2:</b> Apply various CPU scheduling algorithms for process[Level 3 – Apply] management.<br><b>CO3:</b> Apply synchronization techniques to handle concurrency[Level 3 – Apply] problems.<br><b>CO4:</b> Apply deadlock detection and recovery methods in[Level 3 – Apply] operating systems.<br><b>CO5:</b> Explain various memory management techniques used in[Level 3 -Apply] operating systems. |                                                              |             |
| Course Content:                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                              |             |
| Module 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Introduction to Operating Systems                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Assessment: Assignment<br>(Programming using Keras/Sklearn)  | 9 Sessions  |
| Topics:<br>Introduction to OS , Operating-System Operations, Operating Systems Services, , System Calls and its types, Operating Systems Structure, System Program and its types, Linkers and Loaders, Overview of OS design and implementation, Open-source Operating Systems                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                              |             |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Process Management                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Assessment : Quiz + Assignment<br>(Sklearn/Statsmodels)      | 12 Sessions |
| Topics:<br>Process Concept, Operations on Processes, Inter Process Communication, Communication in client-server systems (sockets, RPC, Pipes), Introduction to threads - Multithreading Models, Thread Libraries, Threading Issues, Process Scheduling– Basic concepts, Scheduling Criteria, Scheduling Algorithms: FCFS, SJF, SRTF, RR and Priority.                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                              |             |
| Module 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Process Synchronization and Deadlocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Assessment : Assignment<br>(Programming using Keras/Sklearn) | 12 Sessions |
| The Critical-Section Problem- Peterson’s Solution, Synchronization hardware, Semaphores, Classic Problems of Synchronization with Semaphore Solution- Producer-Consumer Problem, Reader-Writer problems, Dining Philosopher’s Problem, . Introduction to Deadlocks, Necessary conditions for deadlock, Resource allocation Graph, Methods for handling deadlock: Deadlock Prevention and Implementation, Deadlock Avoidance and Implementation, Deadlock detection & Recovery from Deadlock. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                              |             |
| Module 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Memory Management                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Assessment : Programming Assignment<br>(Keras/TensorFlow)    | 12 Sessions |
| Topics:<br>Introduction to Memory Management, Basic hardware-Base and Limit Registers, Memory Management Unit(MMU), Dynamic loading and linking, Swapping, Contiguous and Non-Contiguous Memory Allocation, Segmentation, Paging - Structure of the Page Table – Virtual Memory and Demand Paging – Page Faults and Page Replacement Algorithms. Copy-on-write. Allocation of Frames. Thrashing                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                              |             |

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| Introduction to File system management: File System Interface (access methods, directory structures), File system implementation.                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                    |
| <b>Project work/Assignment :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                    |
| <ol style="list-style-type: none"> <li>1. Demonstrate process concepts in LINUX OS.</li> <li>2. Simulation of CPU scheduling algorithms.</li> <li>3. Develop program to demonstrate use of Semaphores in threads.</li> <li>4. Develop program to demonstrate use of deadlock avoidance algorithms.</li> <li>5. Develop program to demonstrate use of page replacement algorithms.</li> <li>6. Simulation of memory allocation strategies [first fit, best fit and worst fit].</li> </ol> |                                                                                                                                                                                                                    |
| Targeted Applications & Tools:                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                    |
| Use cases                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Application area is traffic management system, banking system, health care and many more systems where in there are resources and entities that use and manage the resources.                                      |
| Oracle Virtual Box/VMWare Virtualization software [Virtual Machine Managers]                                                                                                                                                                                                                                                                                                                                                                                                             | Used to install and work on multiple guest Operating Systems on top of a host OS.                                                                                                                                  |
| Intel Processor identification utility                                                                                                                                                                                                                                                                                                                                                                                                                                                   | This software is used to explain about multi-core processors. It helps to identify the specifications of your Intel processor, like no of cores, Chipset information, technologies supported by the processor etc. |
| Skill-Building Activities through Experiential Learning:                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                    |
| <ul style="list-style-type: none"> <li>• Comparative Analysis of Ensemble Techniques</li> </ul> <p>Learners experiment with ensemble models like Random Forest, AdaBoost, and Gradient Boosting, conducting comparative studies on model variance, bias, and robustness. Through group assignments, students simulate real-world decision-making scenarios where ensemble strategies outperform individual models.</p>                                                                   |                                                                                                                                                                                                                    |
| <ul style="list-style-type: none"> <li>• Neural Network Construction Using Keras</li> </ul> <p>Using the Keras API, students build and train basic feedforward neural networks. They gain practical experience in selecting activation functions, configuring loss functions, tuning hyperparameters (e.g., learning rate, epochs), and applying backpropagation using optimizers like SGD and Adam.</p>                                                                                 |                                                                                                                                                                                                                    |
| <ul style="list-style-type: none"> <li>• Unsupervised Learning for Pattern Discovery</li> </ul> <p>Through clustering algorithms such as K-Means, Hierarchical Clustering, DBSCAN, and Gaussian Mixture Models (GMM), learners segment real-world datasets and visualize clusters. They apply evaluation methods like the Elbow Method and Silhouette Score to validate clustering quality.</p>                                                                                          |                                                                                                                                                                                                                    |
| Text Book                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                    |
| <b>T1:</b> Silberschatz A, Galvin P B and Gagne G , “Silberschatz's Operating System Concepts”, Paperback, Global Edition Wiley, 2019                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                    |
| References                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                    |
| <b>R1:</b> Silberschatz A, Galvin P B and Gagne G, “Operating System Concepts”, 10th edition Wiley, 2018.                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                    |
| <b>R2:</b> William Stallings, “Operating Systems”, Ninth Edition, By Pearson Paperback, 1 March 2018.                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                    |
| <b>R3:</b> Sundaram RMD, Shriram K V, Abhishek S N, B Chella Prabha, “Cracking the Operating System skills”, Dreamtech, paperback, 2020.                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                    |
| <b>R4:</b> Remzi H. Arpaci-Dusseau Andrea C. Arpaci-dusseau, “Operating Systems: Three Easy Pieces, Amazon digital Services”, September 2018.                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                    |
| E-Resources/Web Resources                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                    |
| 1. <a href="https://www.os-book.com/OS9/">https://www.os-book.com/OS9/</a>                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                    |

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| 2. <a href="https://pages.cs.wisc.edu/~remzi/OSTEP/">https://pages.cs.wisc.edu/~remzi/OSTEP/</a>                             |
| 3. <a href="https://codex.cs.yale.edu/avi/os-book/OS10/index.html">https://codex.cs.yale.edu/avi/os-book/OS10/index.html</a> |

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| Course Code:<br>CSD2009                                                                                                                                                                                                                                                                       | Course Name: Data Handling and Visualization<br>Type of Course: Theory Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | L- T-P- C                        | 2-0-02      |
| Version No.                                                                                                                                                                                                                                                                                   | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                  |             |
| Course Pre-requisites                                                                                                                                                                                                                                                                         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                  |             |
| Co-requisites                                                                                                                                                                                                                                                                                 | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                  |             |
| Anti-requisites                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                  |             |
| Course Description                                                                                                                                                                                                                                                                            | The purpose of the course is to install a strong foundation of scientific process orientation that is the cornerstone of effective data handling, and creative design thinking appended with strong programming skills to create meaningful visualizations of data. The student should have prior knowledge of python programming and basic knowledge of data concepts. The associated laboratory provides an opportunity to strengthen student's skillset in the arena of Data Preprocessing and Visualization. With a good knowledge in the fundamental concepts of the various libraries for handling and visualizing data the student can gain a stronghold in Data Science enabling the student to be an effective analyst for prospective employers. |                                  |             |
| Course Objective                                                                                                                                                                                                                                                                              | <ul style="list-style-type: none"><li>• To introduce students to the fundamentals and workflow of Data Science</li><li>• To impart practical experience with Python tools used in data analysis</li><li>• To develop understanding of data exploration, transformation, and visualization techniques</li><li>• To build foundational knowledge of statistical methods and basic predictive modeling</li></ul>                                                                                                                                                                                                                                                                                                                                              |                                  |             |
| Course Outcomes                                                                                                                                                                                                                                                                               | <b>On successful completion of the course the students shall be able to:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                  |             |
|                                                                                                                                                                                                                                                                                               | <b>C01:</b> Understand the various types of data, apply and classify the principles of data visualization                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | [Level 1-Knowledge]              |             |
|                                                                                                                                                                                                                                                                                               | <b>C02:</b> Illustrate the visualization techniques to a problem and its associated dataset                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | [Level2-Comprehension]           |             |
|                                                                                                                                                                                                                                                                                               | <b>C03:</b> Implement interactive visualization for better insight using various visualization tools                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | [Level2-Comprehension]           |             |
|                                                                                                                                                                                                                                                                                               | <b>C04:</b> Demonstrate the visualization concepts practically using Python                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | [Level 3- Apply]                 |             |
| Course Content:                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                  |             |
| Module 1                                                                                                                                                                                                                                                                                      | Introduction to Data Visualization                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Assessment: Programming Activity | 07 Sessions |
| Topics:<br>Data collection<br>Data Preparation Basic Models<br>Overview of data visualization<br>Data Abstraction<br>Task Abstraction<br>Analysis: Four Levels for Validation<br>Interacting with Databases<br>Data Cleaning and Preparation<br>Handling Missing Data<br>Data Transformation. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                  |             |

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| Python Libraries: NumPy, pandas, matplotlib, GGplot                                                                                                                                                                                                                                                |                                             |                                                                                                         |             |
| Introduction to pandas Data Structures                                                                                                                                                                                                                                                             |                                             |                                                                                                         |             |
| Module 2                                                                                                                                                                                                                                                                                           | Data Visualization Techniques               | Assessment: Programming Activity                                                                        | 07 Sessions |
| Topics:<br>Scalar and point techniques<br>vector visualization techniques<br>matrix visualization<br>Visualization Techniques for Trees<br>Graphs, and Networks<br>Multidimensional data<br>Visual Variables<br>Networks and Trees<br>Map Color and Other Channels<br>Manipulate View<br>Heat Map. |                                             |                                                                                                         |             |
| Module 3                                                                                                                                                                                                                                                                                           | Visual Analysis of data from various domain | Assessment: Programming Activity                                                                        | 08 Sessions |
| Topics:<br>Time-oriented data visualization<br>Spatial data visualization<br>Text data visualization<br>Multivariate data visualization<br>case studies, Finance- marketing-insurance-healthcare etc.                                                                                              |                                             |                                                                                                         |             |
| Module 4                                                                                                                                                                                                                                                                                           | Visualization of Streaming Data             | Assessment: Programming Activity                                                                        | 08 Sessions |
| Topics:<br>Guidelines for designing successful visualizations<br>Data visualization dos and don'ts<br>Best practices of Data Streaming<br>processing streaming data for visualization<br>presenting streaming data<br>streaming visualization techniques<br>streaming analysis.                    |                                             |                                                                                                         |             |
| Targeted Applications & Tools:                                                                                                                                                                                                                                                                     |                                             |                                                                                                         |             |
| Python                                                                                                                                                                                                                                                                                             |                                             | A versatile programming language widely used for data analysis, visualization, and scientific computing |             |
| Matplotlib                                                                                                                                                                                                                                                                                         |                                             | A plotting library used to create static and interactive visualizations in Python.                      |             |
| Tableau                                                                                                                                                                                                                                                                                            |                                             | A business intelligence and visualization tool used for creating dashboards and reports.                |             |
| Streamlit                                                                                                                                                                                                                                                                                          |                                             | A Python framework for building interactive data visualization and analytics web applications.          |             |
| Text Book                                                                                                                                                                                                                                                                                          |                                             |                                                                                                         |             |
| T1. McKinney, W.(2017). Python for Data Analysis: Data Wrangling with Pandas, NumPy and IPython. 2nd edition. O'Reilly Media.                                                                                                                                                                      |                                             |                                                                                                         |             |
| T2. Munzner, T., "Visualization Analysis and Design", CRC Press, (2015).                                                                                                                                                                                                                           |                                             |                                                                                                         |             |
| T3.Dr. Ossama Embarak, "Data Analysis and Visualization Using Python", Apress,(2018)                                                                                                                                                                                                               |                                             |                                                                                                         |             |
| References                                                                                                                                                                                                                                                                                         |                                             |                                                                                                         |             |
| R1. Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, Author: Wes McKinney, Publisher: O'Reilly Media, 2nd Edition, 2017.                                                                                                                                                  |                                             |                                                                                                         |             |
| R2. Visualization Analysis and Design, Author: Tamara Munzner, Publisher: CRC Press, 2015.                                                                                                                                                                                                         |                                             |                                                                                                         |             |

R3. Data Analysis and Visualization Using Python, Author: Dr. Ossama Embarak, Publisher: Apress, 2018.  
 R4. Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures, Author: Claus O. Wilke, Publisher: O'Reilly Media, 2019.  
 R5. Interactive Data Visualization for the Web, Author: Scott Murray, Publisher: O'Reilly Media, 2nd Edition, 2017.

E-Resources/Web Resources

1. Pandas Documentation
2. NumPy Documentation
3. Matplotlib Documentation
4. Seaborn Documentation
5. Plotly Documentation
6. Streamlit Documentation

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|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------|
| Course Code:<br>CSD2010 | Course Name: Data Handling and Visualization Lab<br>Type of Course: Laboratory Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | L- T-P- C              | 0-0-4-2 |
| Version No.             | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                        |         |
| Course Pre-requisites   | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                        |         |
| Co-requisites           | CSD2009-Data Handling and Visualization                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                        |         |
| Anti-requisites         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                        |         |
| Course Description      | This lab-oriented course provides practical exposure to data acquisition, preprocessing, analysis, and visualization techniques using modern tools and platforms. Students will learn to work with structured and unstructured datasets, perform data cleaning, transformation, and derive insights using descriptive and inferential statistical techniques. The course emphasizes hands-on experience with data visualization libraries and tools to create meaningful graphical representations that support data-driven decision-making.                                                                     |                        |         |
| Course Objective        | 1.To introduce students to the fundamental concepts of data handling, including data acquisition, cleaning, and transformation.<br>2.To provide hands-on experience with tools and libraries used for data manipulation and visualization.<br>3.To develop the ability to perform exploratory data analysis and derive meaningful insights from datasets.<br>4.To equip students with the skills to create effective visual representations of data for communication and decision-making.<br>5.To encourage the use of real-world datasets in solving practical problems through data visualization techniques. |                        |         |
| Course Outcomes         | <b>On successful completion of the course the students shall be able to:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |         |
|                         | <b>C01:</b> Implement cleaning and transforming structured and unstructured data using Python libraries, and apply data abstraction and validation techniques to prepare data for analysis.                                                                                                                                                                                                                                                                                                                                                                                                                      | [Level 2 – Understand] |         |
|                         | <b>C02:</b> Apply appropriate visualization techniques—scalar, vector, matrix, and network-based—along with visual variables and layout manipulations to effectively represent complex and multidimensional data.                                                                                                                                                                                                                                                                                                                                                                                                | [Level 3 – Apply]      |         |
|                         | <b>C03:</b> Analyze and visualize domain-specific datasets, such as those from finance, healthcare, and marketing, using suitable visualization strategies tailored to time-oriented, spatial, textual, and multivariate data.                                                                                                                                                                                                                                                                                                                                                                                   | [Level 4-Aalyze]       |         |
|                         | <b>C04:</b> Implement visualizations for real-time streaming data                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | [Level 3 – Apply]      |         |

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|-----------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|--|
|                                                                                                                                               | by following best practices in streaming analysis, and present dynamic insights through responsive and interactive visual dashboards. |  |
| Course Content:                                                                                                                               |                                                                                                                                       |  |
| <b>List of Laboratory Tasks:</b>                                                                                                              |                                                                                                                                       |  |
| Experiment 1: Collect structured and unstructured data from online sources (CSV, JSON, API, etc.) and load it using Python.                   |                                                                                                                                       |  |
| Experiment 2: Explore and summarize datasets using NumPy and pandas (head, describe, info, etc.).                                             |                                                                                                                                       |  |
| Experiment 3: Perform data cleaning: handle missing values using mean/median/mode/drop strategies.                                            |                                                                                                                                       |  |
| Experiment 4: Perform data transformation: normalization, encoding categorical data, and feature scaling.                                     |                                                                                                                                       |  |
| Experiment 6: Demonstrate task and data abstraction with a case study (e.g., customer dataset), and validate using statistical summaries.     |                                                                                                                                       |  |
| Experiment 6: Visualize scalar and point data using line charts, bar charts, and scatter plots (matplotlib/seaborn).                          |                                                                                                                                       |  |
| Experiment 7: Apply vector visualization techniques (e.g., quiver plots or flow fields).                                                      |                                                                                                                                       |  |
| Experiment 8: Use heatmaps and matrix visualizations to display correlation matrices or similarity scores.                                    |                                                                                                                                       |  |
| Experiment 9: Visualize hierarchical data using tree maps or dendrograms.                                                                     |                                                                                                                                       |  |
| Experiment 10: Create network graphs for social or connectivity datasets using networkx and visualize them.                                   |                                                                                                                                       |  |
| Experiment 11: Apply visual variables (color, shape, size) and map interactions to adjust views (zoom, filter, etc.).                         |                                                                                                                                       |  |
| Experiment 12: Time-series analysis and visualization for stock market data using line plots, moving averages, etc.                           |                                                                                                                                       |  |
| Experiment 13: Visualize spatial data using geopandas or folium (e.g., crime rate by district, COVID-19 map).                                 |                                                                                                                                       |  |
| Experiment 14: Text data visualization using word clouds, word frequency histograms, or topic modeling visualization.                         |                                                                                                                                       |  |
| Experiment 15: Visualize multivariate data from a real-world case (e.g., healthcare: patient records with multiple attributes).               |                                                                                                                                       |  |
| Experiment 16: Demonstrate streaming data analysis techniques (e.g., rolling averages, anomaly detection).                                    |                                                                                                                                       |  |
| Experiment 17: Final mini-project: Design and present a complete streaming data visualization solution with annotations and user interaction. |                                                                                                                                       |  |
| <b>Targeted Applications &amp; Tools:</b>                                                                                                     |                                                                                                                                       |  |
| Python                                                                                                                                        | A versatile programming language widely used for data analysis, visualization, and scientific computing                               |  |
| Matplotlib                                                                                                                                    | A plotting library used to create static and interactive visualizations in Python.                                                    |  |
| Tableau                                                                                                                                       | A business intelligence and visualization tool used for creating dashboards and reports.                                              |  |
| Streamlit                                                                                                                                     | A Python framework for building interactive data visualization and analytics web applications.                                        |  |
| <b>Text Book</b>                                                                                                                              |                                                                                                                                       |  |
| T1. Dr. Ossama Embarak, "Data Analysis and Visualization Using Python", Apress,(2018)                                                         |                                                                                                                                       |  |
| T2. Wes McKinney "Python for Data Analysis" Edition: 3rd Edition (2022)                                                                       |                                                                                                                                       |  |
| Publisher: O'Reilly Media                                                                                                                     |                                                                                                                                       |  |
| <b>References</b>                                                                                                                             |                                                                                                                                       |  |
| R1 : "Interactive Data Visualization for the Web" by Scott Murray- Edition: 2nd Edition (2017)- Publisher:                                    |                                                                                                                                       |  |

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|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| O'Reilly Media                                                                                                                                                                                                                                                                                  |
| <b>E-Resources/Web Resources</b> <ol style="list-style-type: none"> <li>1. Python Official Documentation</li> <li>2. NumPy Documentation</li> <li>3. Pandas Documentation</li> <li>4. Matplotlib Documentation</li> <li>5. Seaborn Documentation</li> <li>6. Streamlit Documentation</li> </ol> |

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| <b>Course Code:</b><br><b>CSS7000</b> | <b>Course Title: Internship</b><br><b>Type of Course: PRW</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>L- T-P- C</b> | <b>0</b> | <b>0</b> | <b>0</b> | <b>2</b> |
| <b>Version No.</b>                    | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                  |          |          |          |          |
| <b>Course Pre-requisites</b>          | Knowledge and Skills related to all the courses studied in previous semesters.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                  |          |          |          |          |
| <b>Anti-requisites</b>                | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                  |          |          |          |          |
| <b>Course Description</b>             | <p>Students observe science and technology in action, develop an awareness of the methods of scientific experimentation, and often get opportunities to see, study, and operate sophisticated and costly equipment. They also get opportunities to work with advanced software tools and modern technologies used in industries and research environments. Students use tools and technologies from emerging fields such as Artificial Intelligence (AI), Machine Learning (ML), Cyber Security, Blockchain, and Data Science to develop solutions for real-world and industry-related problems. They also learn about the implementation of management principles taught in the classroom by observing multidisciplinary teams of experts from engineering, science, economics, operations research, and management dealing with techno-economic problems at both micro and macro levels. The course further enables students to develop and refine their language, communication, teamwork, and interpersonal skills through various activities such as seminars, group discussions, project presentations, and report preparation.</p> <p>The broad-based core education, supported by strong foundations in mathematics, science, and analytical tools, provides the necessary background for students to properly understand and solve practical real-life problems. Students have the flexibility to pursue this course either as Project Work and Dissertation within the university, as Project Work in an Industry, Company, or Research Laboratory, or through Internship Programs in industries and organizations.</p> |                  |          |          |          |          |
| <b>Course Objectives</b>              | The objective of the course is to familiarize the learners with the concepts of Professional Practice and attain Employability Skills through Experiential Learning techniques.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                  |          |          |          |          |
| <b>Course Outcomes</b>                | <p>On successful completion of this course, students shall be able to:</p> <p><b>C01:</b> Identify engineering problems related to local, regional, [Level 2 - Understand] national, and global needs.</p> <p><b>C02:</b> Apply appropriate techniques and modern tools to solve [Level 3 - Apply] engineering problems.</p> <p><b>C03:</b> Design experiments in accordance with standard procedures [Level 4 - Analyze] and specifications.</p> <p><b>C04:</b> Conduct experiments and collect relevant data for analysis. [Level 3 - Apply]</p> <p><b>C05:</b> Interpret experimental results and draw meaningful [Level 6 - Create] conclusions.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                  |          |          |          |          |

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| <b>Course Code:</b><br>APT4006 | <b>Course Title: Logical and Critical Thinking</b><br><b>Type of Course:</b> Audited                                                   | <b>L- T-P-<br/>C</b> | 0-0-2-0 |
| <b>Version No.</b>             | 1.0                                                                                                                                    |                      |         |
| <b>Course Pre-requisites</b>   | Students should have the basic concepts of Logical reasoning and Critical thinking, along with its applications in real life problems. |                      |         |

|                                                                                                                                                                                    |                                                                                                                                                                                                         |            |                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-----------------------|
| Anti-requisites                                                                                                                                                                    | Nil                                                                                                                                                                                                     |            |                       |
| Course Description                                                                                                                                                                 | This is a skill-based training program for the engineering students (Undergraduate). This course is designed to enable the students to enhance their skills in Logical reasoning and Critical thinking. |            |                       |
| Course Objective                                                                                                                                                                   | The objective of the course is to familiarize the learners with concepts in Logical reasoning and Critical thinking through problem solving techniques suitable for their career development.           |            |                       |
| Course Outcomes                                                                                                                                                                    | On successful completion of the course the students shall be able to:                                                                                                                                   |            |                       |
|                                                                                                                                                                                    | CO1: <b>Understand</b> all the concepts.                                                                                                                                                                |            | [Level 2- Understand] |
|                                                                                                                                                                                    | CO2: <b>Apply</b> the concepts in problem solving (Bloom’s taxonomy Level 3)                                                                                                                            |            | [Level 3- Apply]      |
|                                                                                                                                                                                    | CO3: <b>Analyze</b> and structure the reasoning techniques and spatial visualizationskills [Level 4- Analyze]                                                                                           |            |                       |
| Course Content:                                                                                                                                                                    |                                                                                                                                                                                                         |            |                       |
| Module 1                                                                                                                                                                           | Logical Thinking                                                                                                                                                                                        | Assignment | 16 Hours              |
| <b>Topics:</b><br>Syllogisms, Cubes and Dices, Mirror and Water images, Paper cutting and Folding, Embedded figures & Completion of figures, Data Interpretation, Data sufficiency |                                                                                                                                                                                                         |            |                       |
| Module 2                                                                                                                                                                           | Critical Thinking                                                                                                                                                                                       | Assignment | 14 Hours              |
| <b>Topics:</b><br>Analogy, Symbol and Notations, Statement and assumption, Cause of action, Statement and conclusion, Puzzles                                                      |                                                                                                                                                                                                         |            |                       |
| <b>Targeted Application &amp; Tools that can be used:</b><br>Application area: Placement activities and Competitive examinations.<br>Tools: LMS                                    |                                                                                                                                                                                                         |            |                       |
| Evaluation                                                                                                                                                                         | Continuous Evaluation                                                                                                                                                                                   |            |                       |
|                                                                                                                                                                                    | · Topic wise evaluation                                                                                                                                                                                 |            |                       |
|                                                                                                                                                                                    | · Internal Assessments                                                                                                                                                                                  |            |                       |

**Text Book**

1. A new approach to reasoning verbal, non-verbal & analytical by BS Sijwali
2. R S Aggarwal
3. Kiran publications

**References**

1. [www.indiabix.com](http://www.indiabix.com)
2. [www.testbook.com](http://www.testbook.com)
3. [www.youtube.com/c/TheAptitudeGuy/videos](http://www.youtube.com/c/TheAptitudeGuy/videos)

**Topics relevant to Skill Development** Logical reasoning and Critical thinking for Skill Development through Problem solving Techniques. This is attained through assessment component mentioned in course handout.

|                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |         |
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| Course Code:<br><b>LAW7601</b> | Course Name: <b>Indian Constitution</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | L- T-P- C | 1-0-0-0 |
| Version No.                    | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |           |         |
| Course Pre-requisites          | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |           |         |
| Co-requisites                  | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |           |         |
| Anti-requisites                | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |           |         |
| Course Description             | This course is designed to improve the learners' SKILL DEVELOPMENT by using PATICIPATIVE LEARNING techniques. This course aims to familiarize students with fundamentals of Indian Constitution concepts and their relevance to 75+ Years of Republic of India ( <a href="https://constitution75.com/">https://constitution75.com/</a> ) as well as #AzaadiKaAmrutMahotsav / Azadi Ka Amrit Mahotsav ( <a href="https://amritmahotsav.nic.in">https://amritmahotsav.nic.in</a> ). It is designed to equip students with the knowledge about the Constitution of India. This course aims to introduce the constitutional law of India to students from all walks of life and help them understand the constitutional principles as applied and understood in everyday life. The objective of making the Constitution of India, familiar to all students, and not only to law students, this course aims and objectifies legal understanding in the simplest of forms.<br><b>This course is designed to cater to Constitutional Studies.</b> |           |         |
| Course Objective               | The objective of the course is 'SKILL DEVELOPMENT' of the student by using 'PARTICIPATIVE LEARNING' techniques                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |         |
| Course Outcomes                | <b>On successful completion of the course the students shall be able to:</b><br><br><b>CO1:</b> Describe the basic understanding of the Indian Constitution and the concepts and issues relevant to day-to-day life of the nation and equip citizens with the zeal for capacity building. Level 2 – Understand<br><b>CO2:</b> Recognize and identify the values of the Constitution of India. Level 1 – Remember<br><b>CO3:</b> Explain citizen-centric awareness of the rights and responsibilities of the State. Level 2 – Understand<br><b>CO4:</b> Explain the role of State actors in building India. Level 2 – Understand                                                                                                                                                                                                                                                                                                                                                                                                            |           |         |
| Course Content:                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |         |
| <b>Module 1</b>                | <b>Understanding the Making of the Constitution: The Constituent Assembly</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |         |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>&amp; The Constitution of India</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Topics:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Historical Context of Constituent Assembly - Compositions & Functions of Constituent Assembly<br>What is a Constitution? – Why have a Constitution? – Constitutional Change - Features of Indian Constitution – Preamble of Indian Constitution                                                                                                                                                                                                                                                                                                                 |
| <b>Module 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Citizen's Fundamental Rights and State's Responsibilities (Directive Principles)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Topics:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Introduction to Fundamental Rights - Right to Equality – Facets of Right to Equality - Right to Freedom - Constitutional Position of Some Democratic Rights - Right Against Exploitation - Right to Freedom of Religion - Right to Constitutional Remedies<br>Directive Principles of the State Policy                                                                                                                                                                                                                                                          |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Organs Of the Government</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Topics:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Executive:</b> The President of India - Powers and Functions of President of India - Emergency Powers and the Position of the President<br><b>Legislature:</b> Union Council of Ministers - Prime Minister - The Rajya Sabha - The Lok Sabha - Relation between the Lok Sabha & Rajya Sabha - Office of the Speaker – Important Parliamentary Committees<br><b>Judiciary:</b> The Structure and Organization of the Judiciary & the High Court - The Supreme Court - Role of The Supreme Court - Judicial Activism in India - Basic Structure Doctrine & PIL |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Federalism &amp; Decentralization</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Topics:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | What is Federalism? - Centre-State Legislative Relations - Centre-State Administrative Relations - Centre-State Financial Relations<br>The 5th & 6th Schedules - Municipality- (History of Indian Municipality, Organization & Functions) – Panchayat 1 (Idea of Panchayat, Organization and Powers of Panchayats in India)                                                                                                                                                                                                                                     |
| <b>Targeted Application &amp; Tools that can be used:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Application areas to familiarize students with fundamentals of Indian Constitutional concepts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Tools:</b> Online Tools – NPTEL and Swayam.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Project work/Assignment:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Assessment Type</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Online end term exam will be conducted as notified by the Presidency University.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Online Link*:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 1. Prof. Amitabha Ray, SWAYAM Course: “Constitutional Government & Democracy in India”<br><a href="https://onlinecourses.swayam2.ac.in/cec19_hs13/preview">https://onlinecourses.swayam2.ac.in/cec19_hs13/preview</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| * Other source links are available in below Resources link.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Text Book</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <ol style="list-style-type: none"> <li>1. Durga Das Basu --- Introduction to the Constitution of India, 23rd Edition (Gurgaon; LexisNexis, 2018).</li> <li>2. MP Jain's Constitutional Law of India, Lexis Nexis</li> <li>3. V.N Shukla's Indian Constitutional Law, M.P Singh 13th Edition</li> <li>4. MV Pylee's Constitution of India</li> <li>5. J.C.Johari -- The Constitution of India: A Politico-Legal Study (Greater Noida: Sterling Publishers Pvt. Ltd. 2013).</li> <li>6. Himangshu Roy and M.P.Singh – Indian Political System, 4th Edition (Bengaluru; Pearson Education, 2018)</li> <li>7. Vidya Bhushan &amp; Vishnoo Bhagwan--- Indian Administration (S. Chand, 2011)</li> <li>8. S.R.Maheswari --- Indian Administration (Orient Blackswan, 2001)</li> <li>9. Dr. A.Avasthi &amp; A.P. Avasthi --- Indian Administration (L.N. Agarwal Educational Publishing, 2017).</li> <li>10. B. L. Fadia --- Indian Government and Politics (Sahitya a. Bhawan, 13th Revised Edition, 2017).</li> <li>11. P.M.Bakshi – The Constitution of India (Prayagraj, UP; a. Universal Law Publishing, January, 2018)</li> </ol> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

**Reference Books**

1. HM Seervai, Constitutional Law of India, 4<sup>th</sup> Ed. Vol I, II, & III
2. Uday Raj Rai, Constitutional Law-I
3. Democracy and Constitutionalism in India, Oxford University Press 2009

**Resources:**

1. [https://onlinecourses.nptel.ac.in/noc20\\_lw03/course?&force\\_user=true](https://onlinecourses.nptel.ac.in/noc20_lw03/course?&force_user=true)
2. [https://onlinecourses.swayam2.ac.in/cec19\\_hs13/course?&force\\_user=true](https://onlinecourses.swayam2.ac.in/cec19_hs13/course?&force_user=true)
3. <https://nptel.ac.in/courses/129106003>
4. <https://nptel.ac.in/courses/129106411>
5. <https://nptel.ac.in/courses/129105608>
6. <https://nptel.ac.in/courses/129106002>

**Topics relevant to Skill Development:**

1. An attitude of inquiry.
2. Write reports

**The topics related to Constitutional Studies and its application :**

All topics in theory component are relevant to Indian Constitution.

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|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|----------|----------|----------|----------|
| <b>Course Code:</b><br>CSS2271 | <b>Course Title:</b> Software Design and Development<br><b>Type of Course:</b> Theory Course (PCC)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>L- T-P- C</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |
| <b>Version No.</b>             | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                  |          |          |          |          |
| <b>Course Pre-requisites</b>   | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                  |          |          |          |          |
| <b>Anti-requisites</b>         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                  |          |          |          |          |
| <b>Course Description</b>      | This course introduces foundational concepts of software engineering and emphasizes a practical, structured approach to software system development. It spans software requirement analysis, process modeling, system design, Agile principles, DevOps culture, testing strategies, quality assurance, and software maintenance. Hands-on assignments and problem-solving foster understanding of contemporary software practices and industry tools such as CASE tools, GitHub, and Selenium. AI-enhanced tools are introduced for documentation, automation, and intelligent testing workflows                                                                                                                                                        |                  |          |          |          |          |
| <b>Course Objectives</b>       | To develop a comprehensive understanding of software engineering by enabling students to analyze software development life cycle models, apply design principles and patterns, develop modular and maintainable software systems, perform testing and quality assurance, and manage software projects effectively.                                                                                                                                                                                                                                                                                                                                                                                                                                      |                  |          |          |          |          |
| <b>Course Outcomes</b>         | <p>On successful completion of this course, students will be able to:</p> <p><b>C01:</b><br/>Explain software engineering principles, ethics, and various software development life cycle models. [Understand]</p> <p><b>C02:</b><br/>Identify software requirements and develop design models, including Software Requirement Specification (SRS) documents. [Apply]</p> <p><b>C03:</b><br/>Apply Agile development practices and DevOps principles in software development. [Apply]</p> <p><b>C04:</b><br/>Apply software testing strategies, configuration management, and maintenance techniques. [Apply]</p> <p><b>C05:</b><br/>Evaluate software design and development practices to ensure quality, reliability, and scalability. [Evaluate]</p> |                  |          |          |          |          |

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| <b>Course Content:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                |                    |
| <b>Module 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Introduction to Software Engineering and Process Models</b> | <b>10 Sessions</b> |
| <b>Introduction:</b> Need for Software Engineering, Professional Software Development, Software Engineering Ethics, Software Engineering Practice-Essence of Practice, General Principles Software Development Life Cycle. <b>Models:</b> Waterfall Model – Classical Waterfall Model, Iterative Waterfall Model, Evolutionary model-Spiral, Prototype.                                                                                                                                                                                                                                                                                                                              |                                                                |                    |
| <b>Module 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Software Requirements, Analysis and Design</b>              | <b>12 Sessions</b> |
| <b>Requirements Engineering:</b> Eliciting requirements, Functional and non- Functional requirements, Software Requirements Specification (SRS), Requirement Analysis and validation. Requirements modelling- Introduction to Use Cases, Activity diagram and Swim lane diagram. CASE support in Software Life Cycle, Characteristics of CASE Tools, Architecture of a CASE Environment.<br><b>Design:</b> Design concepts, Architectural design, Component based design, User interface design.                                                                                                                                                                                     |                                                                |                    |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Agile Principles &amp; Devops</b>                           | <b>10 Sessions</b> |
| <b>Agile:</b> Scrum Roles and activities, Sprint Agile software development methods - Scaling, User Stories, Agile estimation techniques, Product backlogs, Stake holder roles, Dynamic System Development Method. <b>DevOps:</b> Introduction, definition, history, tools.                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                |                    |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Software Testing and Maintenance</b>                        | <b>13 Sessions</b> |
| <b>Software Testing-</b> verification and validation, Test Strategies - White Box Testing, Black box Testing, Automation Tools for Testing.<br><b>Software Quality Assurance-</b> Elements of software quality assurance, SQA Tasks, Goals and Metrics, Software configuration management- SCM process, SCM Tools (GitHub).<br><b>Maintenance-</b> Characteristics of Software Maintenance, Software Reverse Engineering, Software Maintenance Process Models.                                                                                                                                                                                                                       |                                                                |                    |
| <b>Targeted Application &amp; Tools that can be used:</b><br><b>Git hub/Lambda/Taskade/Bit.ai/Testsigma/TestRogor</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                |                    |
| <b>Text Books:</b><br>T1. Roger S. Pressman, “Software Engineering – A Practitioner’s Approach”, VII Edition, McGraw-Hill, 2017.<br>T2. Bob Hughes, Mike Cotterell, Rajib Mall, “Software Project Management”, VI Edition, McGraw-Hill, 2018.                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                |                    |
| <b>References:</b><br>R1. Rajib Mall, “Fundamentals of Software Engineering”, VI Edition, PHI learning private limited, 2015.<br>R2. Ian Sommerville, “Software Engineering”, IX Edition, Pearson Education Asia, 2011.<br>R3. Agile Software Development Principles, Patterns and Practices.1st Edition, Wiley, 2002<br><br><b>Journals / Magazines</b> <ul style="list-style-type: none"> <li>• IEEE Software</li> <li>• ACM Transactions on Software Engineering and Methodology</li> <li>• Journal of Systems and Software</li> </ul> <b>SWAYAM / NPTEL / MOOCs</b> <ul style="list-style-type: none"> <li>• NPTEL – Software Engineering (Prof. Rajib Mall, IIT KGP)</li> </ul> |                                                                |                    |

- Coursera – Agile Development (University of Virginia)
- Udemy – DevOps Masterclass
- EdX – Software Testing Fundamentals (TUM)

**Topics Relevant to “Skill Development”:** Black box Testing, White box Testing, AI tools for design, modelling, testing and document Automated Testing for Skill development through Participative Learning Techniques. This is attained through assessment mentioned in the course handout

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| <b>CourseCode</b><br>: ADS2505 | <b>Course Name:</b> Deep Learning and Reinforcement Learning Techniques for Data Science<br><b>Type of Course:</b> Program Core/Theory Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>L-T-P-C</b> | 3-0-0-3 |
| <b>VersionNo.</b>              | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                |         |
| <b>NCrFLevel</b>               | 6.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                |         |
| <b>CoursePre-requisites</b>    | Machine Learning for Intelligent Data Science; Linear Algebra and Vector Calculus; Probability and Statistics; Exploratory Data Analysis; Computational Thinking using Python                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                |         |
| <b>Co-requisites</b>           | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                |         |
| <b>Anti-requisites</b>         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                |         |
| <b>CourseDescription</b>       | This course introduces advanced machine learning techniques with a focus on deep learning and reinforcement learning for solving complex data science problems. Students will learn the theoretical foundations of neural networks, deep architectures, optimization techniques, and sequential decision-making methods used in reinforcement learning. The course also covers practical implementation of deep learning models for image, text, and time-series data using modern frameworks such as TensorFlow and PyTorch.                                                                                                                                                                                                                                    |                |         |
| <b>CourseObjective</b>         | This course aims to develop learners' employability skills by providing practical exposure to deep learning and reinforcement learning techniques used in modern data-driven intelligent systems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                |         |
| <b>CourseOutcomes</b>          | <p><b>On successful completion of the course the student shall be able to:</b></p> <p><b>C01:</b> Explain the fundamental concepts of deep learning [Level 2 – Understand] architectures and neural networks.</p> <p><b>C02:</b> Apply deep learning algorithms for solving real-world [Level 3 – Apply] data science problems.</p> <p><b>C03:</b> Analyze reinforcement learning methods for [Level 4 – Analyze] sequential decision-making problems.</p> <p><b>C04:</b> Analyze deep learning architectures including [Level 4 – Analyze] convolutional neural networks, recurrent neural networks, and transformer models.</p> <p><b>C05:</b> Apply deep learning and reinforcement learning [Level 3 – Apply] techniques to develop intelligent systems.</p> |                |         |

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| <b>CourseContent:</b>                                                                                                                                                                                                                                                                                          |                                                                                                                                             |                                                                                                |                   |
| <b>Module 1</b>                                                                                                                                                                                                                                                                                                | <b>FoundationsofDeepLearning</b>                                                                                                            | <b>Assessment: Assignment (Neural Network Implementation using TensorFlow/Keras)</b>           | <b>9Sessions</b>  |
| Introduction to deep learning – Artificial Neural Networks – Perceptron and Multilayer Perceptron – Activation functions – Loss functions – Gradient descent optimization – Backpropagation algorithm – Regularization techniques (Dropout, Batch Normalization) – Model evaluation basics.                    |                                                                                                                                             |                                                                                                |                   |
| <b>Module 2</b>                                                                                                                                                                                                                                                                                                | <b>Deep Neural Network Architectures</b>                                                                                                    | <b>Assessment: Programming Assignment (CNN/RNN using Keras or PyTorch)</b>                     | <b>9 Sessions</b> |
| Convolutional Neural Networks (CNNs): convolution and pooling layers – Image classification using CNNs – Recurrent Neural Networks (RNNs) – LSTM and GRU architectures – Sequence modelling for time-series and text data – Autoencoders – Representation learning – Introduction to deep learning frameworks. |                                                                                                                                             |                                                                                                |                   |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                | <b>Reinforcement Learning Fundamentals</b>                                                                                                  | <b>Assessment: Quiz + Assignment (Reinforcement Learning Algorithms)</b>                       | <b>9 Sessions</b> |
| Introduction to reinforcement learning – Markov Decision Processes (MDP) – Policies, rewards, and value functions – Dynamic programming – Monte Carlo methods – Temporal Difference learning – Q-learning algorithm – Deep Q Networks (DQN) – Exploration vs exploitation.                                     |                                                                                                                                             |                                                                                                |                   |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                | <b>Advanced Deep Learning Techniques</b>                                                                                                    | <b>Assessment: Assignment (Transformer and Deep RL Models)</b>                                 | <b>9 Sessions</b> |
| Transfer learning and fine-tuning – Attention mechanisms – Transformer models overview – Advanced optimization techniques – Hyperparameter tuning – Introduction to deep reinforcement learning – Policy gradient methods – Actor-critic methods.                                                              |                                                                                                                                             |                                                                                                |                   |
| <b>Module 5</b>                                                                                                                                                                                                                                                                                                | <b>Applications of Deep Learning and Reinforcement Learning</b>                                                                             | <b>Assessment: Mini Project (Deep Learning/Reinforcement Learning Application Development)</b> | <b>9 Sessions</b> |
| Applications in computer vision (image classification, object detection) – Natural language processing (text classification, translation) – Recommendation systems – Robotics and autonomous systems – Case studies of real-world intelligent systems – Model deployment basics.                               |                                                                                                                                             |                                                                                                |                   |
| <b>TargetedApplications&amp;Tools:</b>                                                                                                                                                                                                                                                                         |                                                                                                                                             |                                                                                                |                   |
| <b>Python(NumPy,pandas)</b>                                                                                                                                                                                                                                                                                    | Datapreprocessing,analysis,andnumericalcomputation.                                                                                         |                                                                                                |                   |
| <b>TensorFlowandKeras</b>                                                                                                                                                                                                                                                                                      | BuildingandtrainingdeeplearningmodelssuchasCNNsandneural networks.                                                                          |                                                                                                |                   |
| <b>PyTorch</b>                                                                                                                                                                                                                                                                                                 | Flexibledeeplearningframeworkfor researchand experimentation.                                                                               |                                                                                                |                   |
| <b>Scikit-learnformodevaluation</b>                                                                                                                                                                                                                                                                            | Modevaluation,preprocessing,andintegrationwithmachinelearni ng workflows.                                                                   |                                                                                                |                   |
| <b>JupyterNotebook/GoogleColab</b>                                                                                                                                                                                                                                                                             | Interactiveenvironmentsforimplementing,testing,anddocumenting machinelearningexperiments withbuilt-invisualizationandhardware acceleration. |                                                                                                |                   |
| <b>Skill-BuildingActivitiesthroughExperientialLearning:</b>                                                                                                                                                                                                                                                    |                                                                                                                                             |                                                                                                |                   |

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| <ul style="list-style-type: none"> <li>• <b>NeuralNetworkImplementation:</b><br/>StudentsbuildArtificialNeuralNetworks(ANNs)andMultilayerPerceptrons(MLPs)tounderstand backpropagation, activation functions, and optimization techniques.</li> <li>• <b>DeepLearningModelDevelopment:</b><br/>LearnersimplementConvolutionalNeuralNetworks(CNNs)forimageclassificationandRecurrent Neural Networks (RNNs) or LSTM models for sequence and time-series data analysis.</li> <li>• <b>ReinforcementLearningExperiments:</b><br/>StudentsdevelopreinforcementlearningagentsusingalgorithmssuchasQ-LearningandDeepQ Networks (DQN) to solve decision-making tasks.</li> <li>• <b>DeepLearningApplications:</b><br/>Learnersapplydeeplearningtechniquesincomputervision,naturallanguageprocessing,recommen dation systems, and autonomous systems using real-world datasets.</li> </ul> |
| <b>Textbooks</b><br>T1:IanGoodfellow,YoshuaBengio,AaronCourville –DeepLearning,MITPress.<br>T2:RichardS.SuttonandAndrewG.Barto–ReinforcementLearning:AnIntroduction, MITPress.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>References</b><br>R1:FrancoisChollet–DeepLearningwithPython,ManningPublications.<br>R2:AurélienGéron–Hands-OnMachineLearningwithScikit-Learn,Keras,andTensorFlow, O’Reilly.<br>R3:MaximLapan–DeepReinforcementLearningHands-On,Packt Publishing.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>E-Resources/WebResources</b><br>1. <a href="https://www.tensorflow.org">https://www.tensorflow.org</a><br>2. <a href="https://pytorch.org">https://pytorch.org</a><br>3. <a href="https://www.deeplearning.ai">https://www.deeplearning.ai</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

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| Course Code:<br>ADS2506 | Course Name: Deep Learning and Reinforcement Learning Techniques for Data Science Lab<br>Type of Course: Lab Course                                                                                                                                                                                                                                                          | L- T-P- C | 0-0-4-2 |
| Version No.             | 1.0                                                                                                                                                                                                                                                                                                                                                                          |           |         |
| NCrF Level-             | 5.0                                                                                                                                                                                                                                                                                                                                                                          |           |         |
| Course Pre-requisites   | NIL                                                                                                                                                                                                                                                                                                                                                                          |           |         |
| Co-requisites           | ADS205                                                                                                                                                                                                                                                                                                                                                                       |           |         |
| Anti-requisites         | NIL                                                                                                                                                                                                                                                                                                                                                                          |           |         |
| Course Description      | This laboratory course focuses on hands-on implementation of deep learning and reinforcement learning techniques for intelligent data science applications. It covers neural networks, deep learning architectures, optimization techniques, and reinforcement learning algorithms. Students will build intelligent systems using frameworks such as TensorFlow and PyTorch. |           |         |
| Course Objective        | This course provides practical exposure to deep learning and reinforcement learning techniques, enabling students to design and implement intelligent systems for real-world applications.                                                                                                                                                                                   |           |         |

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| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <p>On successful completion of the course the students shall be able to:</p> <p><b>CO1:</b> Recall basic concepts of deep learning and reinforcement learning. [Level 1 – Remember]</p> <p><b>CO2:</b> Explain neural networks and deep learning architectures. [Level 2 – Understand]</p> <p><b>CO3:</b> Apply deep learning models to real-world datasets [Level 3 – Apply]</p> <p><b>CO4:</b> Analyze reinforcement learning algorithms for decision-making problems.. [Level 4- Analyze]</p> <p><b>CO5:</b> Analyze intelligent systems built using deep learning techniques. [Level 4 – Analyze]</p> |
| Course Content:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <p><b>List of Laboratory Tasks:</b></p> <ul style="list-style-type: none"> <li>• <b>Experiment 1: Introduction to Deep Learning Environment</b><br/>Level 1: Understand deep learning concepts and set up TensorFlow/PyTorch environment.</li> <li>• <b>Experiment 2: Perceptron Implementation</b><br/>Level 1: Implement a perceptron model and analyze its classification performance.</li> <li>• <b>Experiment 3: Multilayer Perceptron (MLP)</b><br/>Level 1: Build an MLP model for classification using neural networks.</li> <li>• <b>Experiment 4: Activation Functions Analysis</b><br/>Level 1: Implement and compare activation functions such as ReLU, Sigmoid, and Tanh.</li> <li>• <b>Experiment 5: Backpropagation and Gradient Descent</b><br/>Level 1: Train neural networks using backpropagation and gradient descent.</li> <li>• <b>Experiment 6: Regularization Techniques</b><br/>Level 1: Apply dropout and batch normalization to improve model performance.</li> <li>• <b>Experiment 7: Convolutional Neural Network (CNN)</b><br/>Level 1: Implement CNN architecture for image classification.</li> <li>• <b>Experiment 8: Image Classification using CNN</b><br/>Level 1: Train and evaluate CNN models on image datasets.</li> <li>• <b>Experiment 9: Recurrent Neural Network (RNN)</b><br/>Level 1: Implement RNN for sequential data processing.</li> <li>• <b>Experiment 10: LSTM / GRU Implementation</b><br/>Level 1: Apply LSTM/GRU models for time-series or sequence prediction.</li> <li>• <b>Experiment 11: Autoencoder Implementation</b><br/>Level 1: Build an autoencoder for feature extraction and dimensionality reduction.</li> <li>• <b>Experiment 12: Introduction to Reinforcement Learning</b><br/>Level 1: Understand RL concepts and implement a simple agent-environment model.</li> <li>• <b>Experiment 13: Q-Learning Algorithm</b><br/>Level 1: Develop Q-learning model for solving decision-making problems.</li> <li>• <b>Experiment 14: Deep Q Network (DQN)</b><br/>Level 1: Implement DQN using neural networks for reinforcement learning tasks.</li> <li>• <b>Experiment 15: Mini Project – Deep Learning / RL Application</b></li> </ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

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| Level 1: Develop an end-to-end intelligent system using deep learning or reinforcement learning.       |                                                                       |
| Targeted Applications & Tools:                                                                         |                                                                       |
| Python (NumPy, pandas)                                                                                 | Data preprocessing and analysis.                                      |
| Matplotlib & Seaborn                                                                                   | Visualization                                                         |
| Jupyter Notebook / Google Colab                                                                        | Development environment                                               |
| TensorFlow / PyTorch                                                                                   | Advanced deep learning experiments                                    |
| Skill-Building Activities through Experiential Learning: ·                                             |                                                                       |
| Neural Network                                                                                         | Implementation                                                        |
| Students build ANN and MLP models                                                                      |                                                                       |
| · Deep Learning Model                                                                                  | Development                                                           |
| Learners implement CNN and RNN models                                                                  |                                                                       |
| · Reinforcement Learning                                                                               | Experiments                                                           |
| Students develop Q-learning and DQN models                                                             |                                                                       |
| Real-World                                                                                             | Applications                                                          |
| Learners build intelligent systems using real datasets                                                 |                                                                       |
| Text Book                                                                                              |                                                                       |
| T1: Ian Goodfellow, Yoshua Bengio, Aaron Courville – <i>Deep Learning</i> , MIT Press                  |                                                                       |
| T2: Richard S. Sutton and Andrew G. Barto – <i>Reinforcement Learning: An Introduction</i> , MIT Press |                                                                       |
| References                                                                                             |                                                                       |
| R1: Francois Chollet – <i>Deep Learning with Python</i>                                                |                                                                       |
| R2: Aurélien Géron – <i>Hands-On Machine Learning</i>                                                  |                                                                       |
| R3: Maxim Lapan – <i>Deep Reinforcement Learning Hands-On</i>                                          |                                                                       |
| E-Resources/Web Resources                                                                              |                                                                       |
| ·                                                                                                      | <a href="https://www.tensorflow.org">https://www.tensorflow.org</a>   |
| ·                                                                                                      | <a href="https://pytorch.org">https://pytorch.org</a>                 |
| ·                                                                                                      | <a href="https://www.deeplearning.ai">https://www.deeplearning.ai</a> |
| ·                                                                                                      | <a href="https://www.kaggle.com">https://www.kaggle.com</a>           |
| · <a href="https://colab.research.google.com">https://colab.research.google.com</a>                    |                                                                       |

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| Course Code:<br>ADS2503 | Course Name: Natural Language Understanding and Analytics<br>Type of Course: Program Core/Theory Course | L- T-P- C | 3-0-0-3 |
| Version No.             | 1.0                                                                                                     |           |         |
| NCrF Level-             | 6.0                                                                                                     |           |         |

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| Course Pre-requisites                                                                                                                                                                                                                                                                                                                 | Machine Learning for Intelligent Data Science; Exploratory Data Analysis; Probability and Statistics; Computational Thinking using Python                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                              |             |
| Co-requisites                                                                                                                                                                                                                                                                                                                         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                              |             |
| Anti-requisites                                                                                                                                                                                                                                                                                                                       | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                              |             |
| Course Description                                                                                                                                                                                                                                                                                                                    | This course introduces the fundamental concepts and techniques used in Natural Language Processing (NLP) and Natural Language Understanding for analyzing textual data. It focuses on linguistic representations, text preprocessing, language modeling, and machine learning methods used to extract insights from large text corpora. Students will learn to build systems for tasks such as sentiment analysis, text classification, information extraction, and topic modeling using modern NLP tools.                                                                                                                                                                                                                                                                |                                                                              |             |
| Course Objective                                                                                                                                                                                                                                                                                                                      | This course aims to improve learners’ employability skills by providing practical knowledge in natural language understanding and text analytics through experiential learning.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                              |             |
| Course Outcomes                                                                                                                                                                                                                                                                                                                       | On successful completion of the course the students shall be able to:<br><br><b>C01:</b> Explain the fundamental concepts of natural language processing and text analytics. [Level 2 - Understand]<br><b>C02:</b> Apply text preprocessing and representation techniques to analyze textual datasets. [Level 3 - Apply]<br><b>C03:</b> Analyze text data using machine learning algorithms for classification and sentiment analysis. [Level 4 - Analyze]<br><b>C04:</b> Analyze advanced natural language processing techniques including named entity recognition, transformer models, and conversational systems. [Level 4 - Analyze]<br><b>C05:</b> Apply natural language processing techniques to develop solutions for real-world applications. [Level 3 - Apply] |                                                                              |             |
| Course Content:                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                              |             |
| Module 1                                                                                                                                                                                                                                                                                                                              | Foundations of Natural Language Processing                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Assessment: Assignment (Text Preprocessing using Python/NLTK)                | 9 Sessions  |
| Introduction to Natural Language Processing – Applications and challenges – Levels of linguistic analysis (morphology, syntax, semantics, pragmatics) – Text preprocessing techniques (tokenization, stop-word removal, stemming, lemmatization) – Regular expressions for text processing – Introduction to NLP tools and libraries. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                              |             |
| Module 2                                                                                                                                                                                                                                                                                                                              | Text Representation Techniques                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Assessment: Quiz + Assignment (Feature Extraction using Scikit-learn)        | 9 Sessions  |
| Vector space representation of text – Bag-of-Words model – TF-IDF representation – N-grams – Similarity measures for textual data – Feature extraction techniques – Limitations of basic representations.                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                              |             |
| Module 3                                                                                                                                                                                                                                                                                                                              | Language Models and Word Embeddings                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Assessment: Programming Assignment (Word Embeddings using Gensim/TensorFlow) | 11 Sessions |
| Statistical language models – Probability-based text modeling – Word embeddings – Word2Vec and GloVe – Contextual representations – Introduction to transformer-based embeddings – Applications of embeddings in NLP.                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                              |             |

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| Module 4                                                                                                                                                                                                                                                 | Machine Learning for Text Analytics                                                                                                                     | Assessment: Assignment (Text Classification and Sentiment Analysis)        | 12 Sessions |
| Text classification techniques – Sentiment analysis methods – Supervised learning algorithms (Naïve Bayes, Logistic Regression, SVM) – Topic modelling (LDA) – Model evaluation (precision, recall, F1-score) – Feature selection for NLP tasks.         |                                                                                                                                                         |                                                                            |             |
| Module 5                                                                                                                                                                                                                                                 | Advanced NLP Techniques and Applications                                                                                                                | Assessment: Mini Project (Conversational AI / NLP Application Development) | 12 Sessions |
| Named Entity Recognition (NER) – Information extraction – Question answering systems – Transformer models (BERT overview) – Chatbots and conversational AI – Applications in social media analytics, recommendation systems, and intelligent assistants. |                                                                                                                                                         |                                                                            |             |
| Targeted Applications & Tools:                                                                                                                                                                                                                           |                                                                                                                                                         |                                                                            |             |
| Python (NLTK, spaCy)                                                                                                                                                                                                                                     | Text preprocessing, linguistic analysis, and NLP pipeline development.                                                                                  |                                                                            |             |
| Scikit-learn (sklearn)                                                                                                                                                                                                                                   | Machine learning algorithms for text classification and sentiment analysis.                                                                             |                                                                            |             |
| Hugging Face Transformers                                                                                                                                                                                                                                | Implementing transformer-based NLP models such as BERT                                                                                                  |                                                                            |             |
| Jupyter Notebook / Google Colab                                                                                                                                                                                                                          | Interactive environments for implementing, testing, and documenting machine learning experiments with built-in visualization and hardware acceleration. |                                                                            |             |
| Skill-Building Activities through Experiential Learning:                                                                                                                                                                                                 |                                                                                                                                                         |                                                                            |             |
| <ul style="list-style-type: none"><li>Text Preprocessing and Linguistic Analysis</li></ul> Students perform tokenization, stop-word removal, stemming, lemmatization, and regular expression-based text processing using NLP libraries.                  |                                                                                                                                                         |                                                                            |             |
| <ul style="list-style-type: none"><li>Text Representation and Language Modelling</li></ul> Learners implement Bag-of-Words, TF-IDF, N-grams, and word embedding techniques such as Word2Vec and Glove for representing textual data.                     |                                                                                                                                                         |                                                                            |             |
| <ul style="list-style-type: none"><li>Machine Learning for Text Analytics</li></ul> Students develop text classification and sentiment analysis models using algorithms such as Naïve Bayes, Logistic Regression, and Support Vector Machines.           |                                                                                                                                                         |                                                                            |             |
| <ul style="list-style-type: none"><li>Advanced NLP Applications</li></ul> Learners explore Named Entity Recognition, topic modelling using LDA, and transformer-based models such as BERT to build intelligent NLP systems for real-world applications.  |                                                                                                                                                         |                                                                            |             |
| Textbooks                                                                                                                                                                                                                                                |                                                                                                                                                         |                                                                            |             |
| T1: Daniel Jurafsky and James H. Martin, Speech and Language Processing.<br>T2: Steven Bird, Ewan Klein and Edward Loper, Natural Language Processing with Python, O'Reilly.                                                                             |                                                                                                                                                         |                                                                            |             |
| References                                                                                                                                                                                                                                               |                                                                                                                                                         |                                                                            |             |
| R1: Jacob Eisenstein, Introduction to Natural Language Processing, MIT Press.<br>R2: Delip Rao and Brian McMahan, Natural Language Processing with PyTorch, O'Reilly. R3:Yoav Goldberg, Neural Network Methods for Natural Language Processing.          |                                                                                                                                                         |                                                                            |             |

#### E-Resources/Web Resources

1. <https://www.nltk.org>
2. <https://spacy.io>
3. <https://huggingface.co>

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| Course Code:<br>ADS2504                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Course Name: Natural Language Understanding and Analytics Lab<br>Type of Course: Lab Course                                                                                                                                                                                                                                                                                                                                                                                                                                     | L- T-P- C | 0-0-2-1 |
| Version No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |         |
| NCrF Level-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 5.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |         |
| Course Pre-requisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |         |
| Co-requisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | ADS2503                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |         |
| Anti-requisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |         |
| Course Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | This laboratory course focuses on hands-on implementation of natural language processing and text analytics techniques. It covers text preprocessing, representation, machine learning models for text classification, and advanced NLP techniques such as named entity recognition and transformer-based models.                                                                                                                                                                                                               |           |         |
| Course Objective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | To provide practical exposure to NLP techniques and enable students to analyze and extract insights from textual data.                                                                                                                                                                                                                                                                                                                                                                                                          |           |         |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | On successful completion of the course the students shall be able to:<br><b>CO1:</b> Recall fundamental NLP concepts and tools.. [Level 1 – Remember]<br><b>CO2:</b> Explain text preprocessing and representation techniques. [Level 2 – Understand]<br><b>CO3:</b> Apply machine learning methods for text analytics. [Level 3 – Apply]<br><b>CO4:</b> Analyze advanced NLP techniques such as NER and transformers. [Level 4 – Analyze]<br><b>CO5:</b> Analyze NLP applications for real-world problems. [Level 4 – Analyze] |           |         |
| Course Content:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |         |
| List of Laboratory Tasks:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |         |
| <ul style="list-style-type: none"><li><b>Experiment 1: Introduction to NLP using Python</b><br/>Level 1: Understand NLP basics and explore libraries such as NLTK and spaCy.</li><li><b>Experiment 2: Text Preprocessing Techniques</b><br/>Level 1: Perform tokenization, stop-word removal, stemming, and lemmatization.</li><li><b>Experiment 3: Regular Expressions for Text Processing</b><br/>Level 1: Use regex to clean and extract patterns from textual data.</li><li><b>Experiment 4: Bag-of-Words Representation</b><br/>Level 1: Convert text data into Bag-of-Words representation.</li><li><b>Experiment 5: TF-IDF Implementation</b><br/>Level 1: Apply TF-IDF to represent textual data and analyze importance of words.</li><li><b>Experiment 6: N-gram Analysis</b><br/>Level 1: Generate and analyze n-grams for textual datasets.</li><li><b>Experiment 7: Text Similarity Measures</b><br/>Level 1: Compute similarity between documents using cosine similarity.</li><li><b>Experiment 8: Word Embeddings using Word2Vec/GloVe</b><br/>Level 1: Implement word embeddings and analyze semantic similarity.</li><li><b>Experiment 9: Text Classification using Naïve Bayes</b><br/>Level 1: Build a text classification model using Naïve Bayes.</li></ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |         |

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| <ul style="list-style-type: none"> <li>• <b>Experiment 10: Sentiment Analysis</b><br/>Level 1: Perform sentiment analysis on textual data.</li> <li>• <b>Experiment 11: Topic Modelling using LDA</b><br/>Level 1: Apply Latent Dirichlet Allocation to extract topics from text.</li> <li>• <b>Experiment 12: Named Entity Recognition (NER)</b><br/>Level 1: Extract entities such as names, locations, and organizations using NLP tools.</li> <li>• <b>Experiment 13: Transformer-based Models (BERT)</b><br/>Level 1: Use pre-trained transformer models for text classification or sentiment analysis.</li> <li>• <b>Experiment 14: Chatbot Implementation</b><br/>Level 1: Develop a simple rule-based or ML-based chatbot.</li> <li>• <b>Experiment 15: Mini Project – NLP Application</b><br/>Level 1: Build an end-to-end NLP system (e.g., sentiment analyzer, chatbot, or topic analyzer).</li> </ul> |                                  |
| <b>Targeted Applications &amp; Tools:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                  |
| Python (NLTK, spaCy)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Text preprocessing and NLP tasks |
| Scikit-learn                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Text classification models       |
| Hugging Face Transformers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Advanced NLP models(BERT)        |
| Jupyter Notebook / Google Colab                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Development environment          |
| <b>Skill-Building Activities through Experiential Learning:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                  |
| • Text Preprocessing and Linguistic Analysis<br>Students perform tokenization, stemming, and text cleaning                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                  |
| • Text Representation and Modeling<br>Learners implement BoW, TF-IDF, and embeddings                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                  |
| • NLP Model Development<br>Students build classification and sentiment analysis models                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                  |
| • Advanced NLP Applications<br>Learners develop chatbot and transformer-based applications                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                  |
| <b>Text Book:</b><br>T1: Daniel Jurafsky and James H. Martin – <i>Speech and Language Processing</i><br>T2: Steven Bird – <i>Natural Language Processing with Python</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                  |
| <b>References:</b><br>R1: Jacob Eisenstein – <i>Introduction to NLP</i><br>R2: Delip Rao – <i>NLP with PyTorch</i><br>R3: Yoav Goldberg – <i>Neural Network Methods for NLP</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                  |
| <b>E-Resources/Web Resources:</b><br>• <a href="https://www.nltk.org">https://www.nltk.org</a><br>• <a href="https://spacy.io">https://spacy.io</a><br>• <a href="https://huggingface.co">https://huggingface.co</a><br>• <a href="https://www.kaggle.com">https://www.kaggle.com</a><br>• <a href="https://colab.research.google.com">https://colab.research.google.com</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                  |

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| <b>Course Code:</b> CSS2274  | <b>Course Title:</b> Competitive Programming and Problem Solving<br><b>Type Of Course:</b> Laboratory Course (ESC) | <b>L-T-P-C</b> | 0 | 0 | 4 | 2 |
| <b>Version No.</b>           | 1.0                                                                                                                |                |   |   |   |   |
| <b>Course Pre-requisites</b> | NIL                                                                                                                |                |   |   |   |   |

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| Anti-requisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |    |
| Course Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | The Competitive Programming and Problem Solving course equips students with efficient problem-solving skills for coding competitions and real-world challenges. Starting with brute-force solutions, students learn to optimize time and space complexity using advanced techniques like dynamic programming, greedy algorithms, and backtracking. Hands-on practice on platforms like CodeChef and Codeforces helps tackle problems involving number theory, data structures, and algorithmic paradigms. By understanding CP constraints and fostering a strategic mindset, students gain the confidence to excel in competitions, technical interviews, and practical applications.                                                                                                                                                                                                                                                                                                                                                |    |
| Course Objective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | The objective of the course is to familiarize the learners with the concepts of Competitive Programming and Problem Solving and attain Skill Development through Experiential Learning techniques.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |    |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | On successful completion of the course the students shall be able to:<br><b>CO1:</b> Understand the challenges of online competitive programming platforms, interpret problem constraints and understand brute-force solution approaches used in competitive programming. [Understand]<br><b>CO2:</b> Analyze the time and space complexity of number-theoretic solutions to determine the need for optimization under competitive programming constraints. [Analyze]<br><b>CO3:</b> Apply appropriate algorithmic paradigms and data structures to solve problems within defined time and memory constraints. [Apply]<br><b>CO4:</b> Analyze execution failures and identify algorithmic inefficiencies in solutions involving advanced data structure concepts to redesign optimized solutions within given time and memory constraints. [Analyze]<br><b>CO5:</b> Analyze advanced problem-solving techniques using dynamic programming to evaluate their effectiveness in large-scale competitive programming problems. [Analyze] |    |
| Course Content:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |    |
| Module 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Introduction to Competitive Programming                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | NA |
| <b>Topics:</b><br>Overview of Efficient Coding for Problem Solving and CP: Introduction to competitive programming (CP); revisit of complexity analysis; introduction to online platforms such as codechef, codeforces etc and online submission; constraints during CP, online testing process and common errors such as TLE; use of STL.<br>CP Problem Solving using Advanced Topics: concept of disjoint sets and their efficient representation, algorithmic approaches such as Greedy, Backtracking, Dynamic Programming and applying them for CP problems using bottom-up dynamic programming. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |    |
| Module 2:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Number Theory for Problem-Solving                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | NA |
| <b>Topics:</b><br>Use of Number Theory for problem-solving: reducing time/space complexity of brute force coding solution of Sieve Method, Inverse Module, Euclidian Method of factorization; efficient coding for Permutation Combination; XORing based and pattern-based solutions.                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |    |
| Module 3:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Optimizing Time & Space Using Sequential Storage                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | NA |
| <b>Topics:</b><br>Coding for Optimizing time and Space using Sequential Storage: two pointer approach; problem-solving using arrays and strings such as rotation on sorted arrays, duplicate removal, string matching algorithms; Kadane's algo, stacks, priority-queues and hashing based efficient coding; median based problems and alternate solutions.                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |    |
| Module 4:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Non-Linear Data Structures                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | NA |

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| <b>Topics:</b><br>Applying Non-Linear Data Structures for real-life problems: design of efficient solutions for problems such as finding loops in a linked list, memory efficient DLL, block reversal in LL; problem solving using trees and binary trees, Catalan numbers, applications of graphs, spanning tree and path algos for CP problems with reduced time/space complexity. |                                              |                    |
| <b>Module 5:</b>                                                                                                                                                                                                                                                                                                                                                                     | <b>Problem Solving using Advanced Topics</b> | <b>NA</b>          |
| <b>Topics:</b><br>CP Problem Solving using Advanced Topics: concept of disjoint sets and their efficient representation, algorithmic approaches such as Greedy, Backtracking, Dynamic Programming and applying them for CP problems using bottom-up dynamic programming.                                                                                                             |                                              |                    |
| <b>List of Practical Tasks</b>                                                                                                                                                                                                                                                                                                                                                       |                                              | <b>60 Sessions</b> |
| <b>WEEK 1</b>                                                                                                                                                                                                                                                                                                                                                                        |                                              |                    |
| <b>Lab Sheet 1: Sorting &amp; Ranking</b>                                                                                                                                                                                                                                                                                                                                            |                                              |                    |
| <b>Level 1:</b> Write a program to find the runner who finished in the third position from the given finishing times of N runners.                                                                                                                                                                                                                                                   |                                              |                    |
| <b>Level 2:</b> Write a program to find the top 10 runners along with their bib numbers efficiently for large datasets.                                                                                                                                                                                                                                                              |                                              |                    |
| <b>Lab Sheet 2: Searching Techniques</b>                                                                                                                                                                                                                                                                                                                                             |                                              |                    |
| <b>Level 1:</b> Write a program to check whether a given book ID exists in a library database.                                                                                                                                                                                                                                                                                       |                                              |                    |
| <b>Level 2:</b> Design and implement a system to search books efficiently by title using an appropriate data structure.                                                                                                                                                                                                                                                              |                                              |                    |
| <b>WEEK 2</b>                                                                                                                                                                                                                                                                                                                                                                        |                                              |                    |
| <b>Lab Sheet 3: Cost Calculation</b>                                                                                                                                                                                                                                                                                                                                                 |                                              |                    |
| <b>Level 1:</b> Write a program to calculate the total cost of products in a shopping cart.                                                                                                                                                                                                                                                                                          |                                              |                    |
| <b>Level 2:</b> Design an algorithm to apply multiple discount rules and compute the final bill.                                                                                                                                                                                                                                                                                     |                                              |                    |
| <b>Lab Sheet 4: Modular Arithmetic</b>                                                                                                                                                                                                                                                                                                                                               |                                              |                    |
| <b>Level 1:</b> Write a program to compute $(a^m \mod p)$ .                                                                                                                                                                                                                                                                                                                          |                                              |                    |
| <b>Level 2:</b> Implement binary exponentiation for efficient computation of large powers modulo p.                                                                                                                                                                                                                                                                                  |                                              |                    |
| <b>WEEK 3</b>                                                                                                                                                                                                                                                                                                                                                                        |                                              |                    |
| <b>Lab Sheet 5: Combinatorics</b>                                                                                                                                                                                                                                                                                                                                                    |                                              |                    |
| <b>Level 1:</b> Write a program to calculate the number of ways to choose K cards from N cards.                                                                                                                                                                                                                                                                                      |                                              |                    |
| <b>Level 2:</b> Design an algorithm to calculate probabilities of drawing specific card combinations.                                                                                                                                                                                                                                                                                |                                              |                    |
| <b>Lab Sheet 6: Graph Connectivity</b>                                                                                                                                                                                                                                                                                                                                               |                                              |                    |
| <b>Level 1:</b> Write a program to determine if a path exists between two nodes in a network.                                                                                                                                                                                                                                                                                        |                                              |                    |
| <b>Level 2:</b> Design an algorithm to detect anomalies in a network using XOR-based comparison techniques.                                                                                                                                                                                                                                                                          |                                              |                    |
| <b>WEEK 4</b>                                                                                                                                                                                                                                                                                                                                                                        |                                              |                    |
| <b>Lab Sheet 7: Array Processing</b>                                                                                                                                                                                                                                                                                                                                                 |                                              |                    |
| <b>Level 1:</b> Write a program to find the minimum time required for cars to pass a point based on their speeds.                                                                                                                                                                                                                                                                    |                                              |                    |
| <b>Level 2:</b> Implement a two-pointer approach to simulate movement of cars with different lengths.                                                                                                                                                                                                                                                                                |                                              |                    |
| <b>Lab Sheet 8: String Matching</b>                                                                                                                                                                                                                                                                                                                                                  |                                              |                    |
| <b>Level 1:</b> Write a program to count occurrences of a substring in a given string.                                                                                                                                                                                                                                                                                               |                                              |                    |
| <b>Level 2:</b> Implement the KMP algorithm to efficiently find all occurrences of a pattern in a text.                                                                                                                                                                                                                                                                              |                                              |                    |
| <b>WEEK 5</b>                                                                                                                                                                                                                                                                                                                                                                        |                                              |                    |
| <b>Lab Sheet 9: Priority Queue</b>                                                                                                                                                                                                                                                                                                                                                   |                                              |                    |
| <b>Level 1:</b> Write a program to track the highest bid in an auction system.                                                                                                                                                                                                                                                                                                       |                                              |                    |
| <b>Level 2:</b> Design a system to handle concurrent bids efficiently and update the highest bid.                                                                                                                                                                                                                                                                                    |                                              |                    |
| <b>Lab Sheet 10: Shortest Path</b>                                                                                                                                                                                                                                                                                                                                                   |                                              |                    |
| <b>Level 1:</b> Write a program to check if two users are connected in a social network.                                                                                                                                                                                                                                                                                             |                                              |                    |
| <b>Level 2:</b> Implement Dijkstra's algorithm to find the shortest path between users.                                                                                                                                                                                                                                                                                              |                                              |                    |

## **WEEK 6**

### **Lab Sheet 11: Tree Traversal**

**Level 1:** Write a program to traverse a file system and display all files and directories.

**Level 2:** Design a file system supporting operations like create, delete, and search.

### **Lab Sheet 12: Tree Applications**

**Level 1:** Write a program to calculate the total price of items in a shopping cart represented as a tree.

**Level 2:** Design a system to apply discounts efficiently in a hierarchical shopping cart.

## **WEEK 7**

### **Lab Sheet 13: Disjoint Set**

**Level 1:** Write a program to check whether all users in a group are connected.

**Level 2:** Find the minimum number of connections required to connect all users.

### **Lab Sheet 14: Greedy Algorithms**

**Level 1:** Write a program to find the cheapest path to reach a destination.

**Level 2:** Design an algorithm to find the fastest path considering time constraints.

## **WEEK 8**

### **Lab Sheet 15: BFS Applications**

**Level 1:** Write a program to find the minimum number of moves for a rook to reach a target square.

**Level 2:** Implement BFS to find shortest path in a grid.

### **Lab Sheet 16: Game Algorithms**

**Level 1:** Represent a game state using a tree structure.

**Level 2:** Implement minimax algorithm with alpha-beta pruning.

## **WEEK 9**

### **Lab Sheet 17: Sorting Algorithms**

**Level 1:** Write a program to implement insertion sort.

**Level 2:** Write a program to implement merge sort or quick sort.

### **Lab Sheet 18: Searching Algorithms**

**Level 1:** Write a program to perform linear search.

**Level 2:** Write a program to perform binary search efficiently.

## **WEEK 10**

### **Lab Sheet 19: Algorithm Analysis**

**Level 1:** Write a program to compare execution time of two algorithms.

**Level 2:** Optimize a given algorithm to improve performance.

### **Lab Sheet 20: Recursion**

**Level 1:** Write a program to solve Tower of Hanoi.

**Level 2:** Compare recursive and iterative solutions for a problem.

## **WEEK 11**

### **Lab Sheet 21: Graph Representation**

**Level 1:** Represent a graph using adjacency list.

**Level 2:** Represent a graph using adjacency matrix.

### **Lab Sheet 22: Graph Traversal**

**Level 1:** Implement Depth First Search (DFS).

**Level 2:** Implement Breadth First Search (BFS).

## **WEEK 12**

### **Lab Sheet 23: Data Structure Integration**

**Level 1:** Combine arrays and lists to solve a problem.

**Level 2:** Use multiple data structures (tree + hash table) in one solution.

### **Lab Sheet 24: Real-world Application**

**Level 1:** Design a simple recommendation system.

**Level 2:** Optimize it for large-scale data.

**WEEK 13****Lab Sheet 25: String Algorithms**

**Level 1:** Write a program for basic string matching.

**Level 2:** Implement efficient pattern matching algorithm.

**Lab Sheet 26: Network Algorithms**

**Level 1:** Check connectivity in a network.

**Level 2:** Detect anomalies using data comparison techniques.

**WEEK 14****Lab Sheet 27: Algorithm Design**

**Level 1:** Solve a problem using brute-force approach.

**Level 2:** Improve the solution using greedy or dynamic approach.

**Lab Sheet 28: Performance Evaluation**

**Level 1:** Analyze runtime of a program.

**Level 2:** Compare different algorithmic approaches.

**WEEK 15****Lab Sheet 29: Case Study**

**Level 1:** Implement a real-world problem solution.

**Level 2:** Optimize and document the solution.

**Lab Sheet 30: Mini Project**

**Level 1:** Combine multiple algorithms to build a system.

**Level 2:** Present optimized solution with performance analysis.

**Targeted Application & Tools that can be used:**

1. C or C++ Compiler (g++): The standard compiler for CP. Familiarize students with compilation flags (e.g., -O2 for optimization).
2. IDE (Integrated Development Environment): Code:: Blocks, Visual Studio, CLion, or similar IDEs. These provide debugging capabilities, code completion, and other helpful features.
3. Online Judges (CodeChef, Codeforces, LeetCode, HackerRank): Essential for practicing and submitting solutions.
4. Debugger (gdb): Crucial for understanding code execution and finding bugs. Origin, excel and Mat lab soft wares for programming and data analysis.
5. Number Theory Libraries: Some libraries provide pre-built functions for number theory operations (though often it's better to implement them yourself for learning).
6. Wolfram Alpha: A useful tool for verifying number theory calculations and exploring concepts.
7. String Libraries: Familiarize students with the string manipulation functions available in C++.
8. Graph Visualization Tools: Tools like Graphviz can be helpful for visualizing graphs and understanding graph algorithms.
9. DP Debugging Techniques: Practice debugging DP solutions, as they can be complex. Visualizing the DP table can be helpful

**Text Books:**

1. "Guide to Competitive Programming: Learning and Improving Algorithms Through Contests" (3rd Edition), *Antti Laaksonen, springer, 2024*
2. "Data Structures and Algorithms in Java: A Project-Based Approach" – *Dan S. Myers, Cambridge University Press*

**Reference Books:**

1. "Data Structures and Algorithmic Thinking with Python/C++/Java", Narasimha Karumanchi, 5<sup>th</sup> Edition, Career Monk, 2017.
2. Introduction to Algorithms, [Thomas H. Cormen](#) (Author), [Charles E. Leiserson](#) (Author), [Ronald L. Rivest](#), fourth edition April 2022 .

**Web Resources**

1. <https://nptel.ac.in/courses/106106231>

**Project work/Assignment: Mention the Type of Project /Assignment proposed for this course**

|                                                                                                                                                                                                                                                                                                                             |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Assessment Type</b> <ol style="list-style-type: none"> <li>1. Midterm exam</li> <li>2. Assignment (review of digital/ e-resource from PU link given in references section - mandatory to submit screen shot accessing digital resource.)</li> <li>3. Quiz</li> <li>4. End Term Exam</li> <li>5. Self-Learning</li> </ol> |
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| <b>Course Code: APT4005</b>                                                                                                                                                                                                            | <b>Course Title: Aptitude For Employability</b>                                                                                                                                                                                                                                                                                                                 |           |                           | <b>L- T-P-0-0-2-1</b> |
|                                                                                                                                                                                                                                        | <b>Type of Course: Practical Only</b>                                                                                                                                                                                                                                                                                                                           |           |                           | <b>C</b>              |
| <b>Version No.</b>                                                                                                                                                                                                                     | 1.0                                                                                                                                                                                                                                                                                                                                                             |           |                           |                       |
| <b>Course Pre-requisites</b>                                                                                                                                                                                                           | Students should have the basic concepts of Quantitative aptitude, Verbal ability along with its applications in real life problems.                                                                                                                                                                                                                             |           |                           |                       |
| <b>Anti-requisites</b>                                                                                                                                                                                                                 | Nil                                                                                                                                                                                                                                                                                                                                                             |           |                           |                       |
| <b>Course Description</b>                                                                                                                                                                                                              | This course is designed to enable the students to enhance their skills in quantitative aptitude and verbal ability skills.                                                                                                                                                                                                                                      |           |                           |                       |
| <b>Course Objective</b>                                                                                                                                                                                                                | The objective of the course is to familiarize the learners with concepts in Quantitative Aptitude and Verbal ability through problem solving techniques suitable for their career development.                                                                                                                                                                  |           |                           |                       |
| <b>Course Outcomes</b>                                                                                                                                                                                                                 | On successful completion of the course the students shall be able to:<br>CO1: <b>Recall</b> all the basic mathematical concepts [Level 1- Remember]<br>CO2: <b>Identify</b> the principle concept needed in a question [Level 2- Understand]<br>CO3: <b>Solve</b> the quantitative and logical ability questions with the appropriate concept. [Level 3- Apply] |           |                           |                       |
| <b>Course Content:</b>                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                 |           |                           |                       |
| <b>Module 1</b>                                                                                                                                                                                                                        | Quantitative Ability                                                                                                                                                                                                                                                                                                                                            | Lab-10hrs | Platform Assessment-10hrs | <b>20 Hours</b>       |
| Topics:<br>Number System, Percentage, Ratio and Proportion, Average, Mixture and Allegation, Time and Work, Profit and Loss, Time Speed and Distance, Simple Interest and Compound Interest, Probability, Permutation and Combination. |                                                                                                                                                                                                                                                                                                                                                                 |           |                           |                       |
| <b>Module 2</b>                                                                                                                                                                                                                        | Verbal Ability                                                                                                                                                                                                                                                                                                                                                  | Lab-5hrs  | Platform Assessment-5hrs  | <b>10 Hours</b>       |
| Topics: - Parts of Speech, Subject Verb Agreement, Spotting Error, Cloze Test, Verbal Analogies, Reading Comprehension, Idioms & Phrases, Para Jumbles                                                                                 |                                                                                                                                                                                                                                                                                                                                                                 |           |                           |                       |
| <b>Targeted Application &amp; Tools that can be used:</b><br>Application area: Placement activities and Competitive examinations. Tools: LMS                                                                                           |                                                                                                                                                                                                                                                                                                                                                                 |           |                           |                       |
| <b>Evaluation</b><br><b>Continuous Evaluation</b> <ul style="list-style-type: none"> <li>• Topic wise evaluation</li> </ul>                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                 |           |                           |                       |

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| <b>Text Book</b> <ol style="list-style-type: none"> <li>1. Fast track objective by Rajesh Verma</li> <li>2. R S Aggarwal</li> <li>3. S.P Bakshi</li> </ol>                                                                                                                                                        |
| <b>References</b> <ol style="list-style-type: none"> <li>1. <a href="http://www.indiabix.com">www.indiabix.com</a></li> <li>2. <a href="http://www.testbook.com">www.testbook.com</a></li> <li>3. <a href="http://www.youtube.com/c/TheAptitudeGuy/videos">www.youtube.com/c/TheAptitudeGuy/videos</a></li> </ol> |
| <b>Topics relevant to Skill development:</b> Quantitative and reasoning aptitude for Skill Development through Problem solving Techniques. This is attained through assessment component mentioned in course handout.                                                                                             |

|                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                  |          |          |          |          |
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| <b>Course Code: CSS7100</b>  | <b>Course Title: Mini Project</b><br><b>Type of Course: PRW</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>L- T-P- C</b> | <b>0</b> | <b>0</b> | <b>0</b> | <b>4</b> |
| <b>Version No.</b>           | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                  |          |          |          |          |
| <b>Course Pre-requisites</b> | Knowledge and Skills related to all the courses studied in previous semesters.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                  |          |          |          |          |
| <b>Anti-requisites</b>       | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                  |          |          |          |          |
| <b>Course Description</b>    | <p>Students observe science and technology in action, develop an awareness of the methods of scientific experimentation, and often get opportunities to see, study, and operate sophisticated and costly equipment. They also get opportunities to work with advanced software tools and modern technologies used in industries and research environments. Students use tools and technologies from emerging fields such as Artificial Intelligence (AI), Machine Learning (ML), Cyber Security, Blockchain, and Data Science to develop solutions for real-world and industry-related problems.</p> <p>They also learn about the implementation of management principles taught in the classroom by observing multidisciplinary teams of experts from engineering, science, economics, operations research, and management dealing with techno-economic problems at both micro and macro levels. The course further enables students to develop and refine their language, communication, teamwork, and interpersonal skills through various activities such as seminars, group discussions, project presentations, and report preparation.</p> <p>The broad-based core education, supported by strong foundations in mathematics, science, and analytical tools, provides the necessary background for students to properly understand and solve practical real-life problems. Students have the flexibility to pursue this course either as Project Work and Dissertation within the university, as Project Work in an Industry, Company, or Research Laboratory, or through Internship Programs in industries and organizations.</p> |                  |          |          |          |          |
| <b>Course Objectives</b>     | <p>The objective of the course is to familiarize the learners with the concepts of Professional Practice and attain Employability Skills through Experiential Learning techniques.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                  |          |          |          |          |

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| <b>Course Outcomes</b> | <p>On successful completion of this course, students shall be able to:</p> <p><b>C01:</b> Identify engineering problems related to local, regional, national, and global needs. [Level 2 - Understand]</p> <p><b>C02:</b> Apply appropriate techniques and modern tools to solve the intended problems. [Level 3 - Apply]</p> <p><b>C03:</b> Design experiments in accordance with standards and specifications. [Level 4- Analyze]</p> <p><b>C04:</b> Interpret events and results to derive meaningful conclusions. [Level 5- Evaluate]</p> <p><b>C05:</b> Appraise project findings and communicate effectively through scholarly publications. [Level 6 - Create]</p> |
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| Course code: PPS3018                                                                                    | Course Title: Preparedness for Interview<br>Type of Course: Practical Only Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | L- T- P- C         | 1-0-0-0     |
| Version No.                                                                                             | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                    |             |
| Course Pre-requisites                                                                                   | Students are expected to understand Basic English.<br>Students should have desire and enthusiasm to involve, participate, and learn.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                    |             |
| Co-requisites                                                                                           | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                    |             |
| Anti-requisites                                                                                         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                    |             |
| Course Description                                                                                      | This course is designed to enable students to understand soft skills concepts to be corporate-ready. The modules are set to improve self-confidence, communicate effectively and Prepare for the Interview to assist in employability. It helps the students to get a glimpse of the acceptable corporate readiness and equip them with the fundamental necessities of being able to confidently deal with the highly competitive corporate environment and helps in crafting different types of resumes. The pedagogy used will be group discussions, flipped classrooms, continuous feedback, role-play and mentoring. |                    |             |
| Course Objective                                                                                        | The objective of the course is to familiarize the learners with the concepts of “Preparing for Interview” and attain SKILL DEVELOPMENT through PARTICIPATIVE LEARNING techniques.                                                                                                                                                                                                                                                                                                                                                                                                                                        |                    |             |
| Course Outcomes                                                                                         | <b>On successful completion of the course the students shall be able to:</b><br><br>C01: Develop professional resumes that effectively showcase qualifications, skills, achievements, andL3 – Apply career objectives.<br>C02: Illustrate and organize resume content effectively using appropriate formats, design principles, and professionalL2 – Understand standards.<br>C03: Apply communication skills, subject knowledge, and professional etiquette to participate actively and effectively in group discussions andL3 – Apply interviews.                                                                      |                    |             |
| Course Content:                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                    |             |
| Module 1                                                                                                | Resume Building                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Classroom activity | 10 Sessions |
| Topics: Resume structure, use of templates, Do’s and Don’ts, ATS methods, Cover Letter and Video Resume |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                    |             |

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| Activity: Real world scenarios                                                                                                                                                                                                                       |                                         |                                                                 |            |
| <b>Module 2</b>                                                                                                                                                                                                                                      | <b>Group Discussion</b>                 | <b>Mock G D</b>                                                 | 9 Sessions |
| Topics: -Group discussion as a placement process, GD techniques like Keyword. SPELT & POV of affected parties. Do & Don't of GD, Case-lets and topics for GD, practice session and evaluation<br>Activity:- Real world scenarios                     |                                         |                                                                 |            |
| <b>Module 3</b>                                                                                                                                                                                                                                      | <b>Personal Interview</b>               | <b>Grooming checks + Evaluation + Mock Interview+ Role Play</b> | 9 Sessions |
| <b>Topics:</b> Placement process, Different interview rounds, HR interviews, Interview questions and desired answers, Different types of interviews, Do's and Don'ts.<br><b>Activity:</b> - Role Play & Real-world scenario                          |                                         |                                                                 |            |
| <b>Module 4</b>                                                                                                                                                                                                                                      | <b>Recap/Revision /Feedback Session</b> | <b>Practice sessions</b>                                        | 2 Sessions |
| Targeted Application & Tools that can be used:<br>1. TED Talks<br>2. You Tube Links<br>3. Role Play activities                                                                                                                                       |                                         |                                                                 |            |
| <b>Project work/Assignment: Mention the Type of Project /Assignment proposed for this course</b>                                                                                                                                                     |                                         |                                                                 |            |
| Continuous Individual Assessment                                                                                                                                                                                                                     |                                         |                                                                 |            |
| <b>The Topics related to Skill Development:</b> Art Of Presentation and Group Discussion for <b>Skill Development</b> through <b>Participative Learning</b> Tech- niques. This is attained through assessment Component mentioned in course handout. |                                         |                                                                 |            |

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| <b>Course Code:</b><br>CSS7300 | <b>Course Title: Capstone Project</b><br><b>Type of Course: PRW</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>L- T-P- C</b> | <b>0</b> | <b>0</b> | <b>0</b> | <b>10</b> |
| <b>Version No.</b>             | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                  |          |          |          |           |
| <b>Course Pre-requisites</b>   | Knowledge and Skills related to all the courses studied in previous semesters.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                  |          |          |          |           |
| <b>Anti-requisites</b>         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                  |          |          |          |           |
| <b>Course Description</b>      | <p>Students learn by observing science and technology in real-life applications and gain knowledge through practical experimentation and hands-on activities. They get opportunities to study and work with advanced equipment, software tools, and modern technologies. Students use tools and technologies from emerging fields such as Artificial Intelligence (AI), Machine Learning (ML), Cyber Security, Blockchain, and Data Science to develop solutions for real-world and industry-related problems.</p> <p>The course helps students understand how engineering, science, economics, operations research, and management work together to solve technical and business-related challenges. By working on projects, seminars, group discussions, and report preparation, students improve their communication, teamwork, presentation, and interpersonal skills.</p> <p>The strong foundation in mathematics, science, and analytical thinking helps students understand and solve practical problems effectively. Students can complete the course through Project Work and Dissertation within the university, by doing projects in industries or research laboratories, or through internship programs in companies and organizations.</p> |                  |          |          |          |           |

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| <b>Course Objectives</b> | The objective of the course is to familiarize the learners with the concepts of Professional Practice and attain Employability Skills through Experiential Learning techniques.                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Course Outcomes</b>   | On successful completion of this course, students shall be able to:<br><b>CO1:</b> Identify engineering problems at various societal levels [Level 2 - Understand]<br><b>CO2:</b> Apply tools and techniques for problem solving. [Level 3 - Apply]<br><b>CO3:</b> Design and plan experiments per industry standards. [Level 3- Apply]<br><b>CO4:</b> Interpret the events and results for meaningful conclusions. [Level 5- Evaluate]<br><b>CO5:</b> Appraise project findings and communicate effectively through scholarly publications. [Level 6- Create] |

|                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                             |                   |
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| <b>Course Code:</b><br>ADS3400                                                                            | <b>Course Name:</b> Advanced Machine Learning<br><b>Type of Course:</b> Elective Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>L- T-P- C</b>                                                            | 2-0-2-3           |
| <b>Version No.</b>                                                                                        | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                             |                   |
| <b>NCrF Level</b>                                                                                         | 6.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                             |                   |
| <b>Course Pre-requisites</b>                                                                              | Machine Learning for Intelligent Data Science; Linear Algebra; Probability and Statistics; Exploratory Data Analysis; Computational Thinking using Python                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                             |                   |
| <b>Co-requisites</b>                                                                                      | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                             |                   |
| <b>Anti-requisites</b>                                                                                    | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                             |                   |
| <b>Course Description</b>                                                                                 | This course focuses on advanced concepts and techniques in machine learning used to solve complex real-world problems. It covers ensemble learning, advanced optimization techniques, probabilistic models, and modern approaches such as boosting, bagging, and kernel methods. The course also introduces scalable machine learning and model interpretability techniques. Students will gain both theoretical understanding and practical experience using modern machine learning libraries.                                                                                                                                       |                                                                             |                   |
| <b>Course Objective</b>                                                                                   | This course aims to enhance learners’ skills in designing and implementing advanced machine learning models for real-world applications and improving decision-making capabilities using data-driven approaches.                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                             |                   |
| <b>Course Outcomes</b>                                                                                    | On successful completion of the course the students shall be able to:<br><b>CO1:</b> Explain advanced machine learning concepts such as[Level 2 – ensemble methods and kernel techniques. Understand]<br><b>CO2:</b> Apply advanced algorithms to solve complex data[Level 3 – Apply] science problems.<br><b>CO3:</b> Analyze model performance and optimize machine[Level 4 – Analyze] learning systems.<br><b>CO4:</b> Analyze efficient and scalable machine learning[Level 4 – Analyze] solutions.<br><b>CO5:</b> Analyze machine learning models using[Level 4 – Analyze] explainability techniques and real-world case studies. |                                                                             |                   |
| <b>Course Content:</b>                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                             |                   |
| <b>Module 1</b>                                                                                           | <b>Advanced Supervised Learning</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Assessment: Assignment (SVM and Model Evaluation using Scikit-learn)</b> | <b>6 Sessions</b> |
| Review of supervised learning; Bias-variance tradeoff; Regularization techniques (L1, L2); Support Vector |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                             |                   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                           |                                                                                        |                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|----------------------------------------------------------------------------------------|-------------------|
| Machines (SVM); Kernel methods; Hyperparameter tuning; Cross-validation techniques; Model evaluation strategies.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                           |                                                                                        |                   |
| <b>Module 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Ensemble Learning Techniques</b>                       | <b>Assessment: Programming Assignment (Ensemble Models using Scikit-learn/XGBoost)</b> | <b>6 Sessions</b> |
| Bagging and Boosting concepts; Random Forest algorithm; Gradient Boosting Machines (GBM); AdaBoost; XGBoost and LightGBM; Model stacking and blending; Performance comparison of ensemble models; Practical implementation of ensemble methods.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                           |                                                                                        |                   |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Unsupervised Learning and Dimensionality Reduction</b> | <b>Assessment: Assignment (Clustering and PCA Implementation)</b>                      | <b>6 Sessions</b> |
| Clustering techniques (K-Means, Hierarchical clustering); Cluster evaluation methods; Dimensionality reduction (PCA, t-SNE); Feature extraction techniques; Applications of clustering and dimensionality reduction.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                           |                                                                                        |                   |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Probabilistic Models and Advanced Learning</b>         | <b>Assessment: Quiz + Assignment (Probabilistic Models using Python)</b>               | <b>6 Sessions</b> |
| Gaussian Mixture Models (GMM); Expectation-Maximization (EM) algorithm; Hidden Markov Models (HMM); Anomaly detection techniques; Introduction to probabilistic reasoning; Applications of probabilistic models.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                           |                                                                                        |                   |
| <b>Module 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Advanced Topics and Applications in ML</b>             | <b>Assessment: Mini Project (Applied Machine Learning Case Study)</b>                  | <b>6 Sessions</b> |
| Model interpretability (SHAP, LIME); Feature engineering and selection; Handling imbalanced datasets (SMOTE, resampling); Scalable machine learning; Introduction to AutoML; Ethics in AI and bias mitigation; Case studies.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                           |                                                                                        |                   |
| <b>List of Laboratory Task</b><br><b>Lab 1: Supervised Learning and Model Evaluation</b><br>Review supervised learning concepts and implement classification models using Scikit-learn. Analyze bias-variance tradeoff and evaluate model performance using accuracy, precision, recall, and F1-score.<br><br><b>Lab 2: Regularization Techniques using L1 and L2</b><br>Implement L1 and L2 regularization techniques to reduce overfitting in machine learning models. Compare model performance before and after regularization.<br><b>Lab 3: Support Vector Machine (SVM) Classification</b><br>Implement Support Vector Machines for classification tasks. Use linear and non-linear kernels and analyze classification performance on datasets.<br><b>Lab 4: Hyperparameter Tuning and Cross-Validation</b><br>Perform hyperparameter tuning using Grid Search and Random Search methods. Apply cross-validation techniques and analyze optimized model performance.<br><b>Lab 5: Random Forest Implementation</b><br>Implement Random Forest algorithm for classification and regression problems. Analyze feature importance and compare results with individual decision trees.<br><b>Lab 6: Boosting Techniques using AdaBoost and Gradient Boosting</b><br>Implement AdaBoost and Gradient Boosting algorithms. Compare ensemble model performance and evaluate prediction accuracy.<br><b>Lab 7: XGBoost and LightGBM Models</b><br>Implement advanced boosting algorithms using XGBoost and LightGBM libraries. Tune model parameters and compare efficiency with traditional ensemble methods.<br><b>Lab 8: Model Stacking and Blending</b> |                                                           |                                                                                        |                   |

Implement stacking and blending techniques for combining multiple machine learning models. Analyze performance improvement using ensemble learning approaches.

#### **Lab 9: K-Means Clustering**

Perform clustering using K-Means algorithm. Visualize clusters and analyze cluster quality using evaluation metrics such as Silhouette Score.

#### **Lab 10: Hierarchical Clustering**

Implement hierarchical clustering methods and analyze cluster formation using dendrograms. Compare results with K-Means clustering.

#### **Lab 11: Dimensionality Reduction using PCA and t-SNE**

Apply dimensionality reduction techniques such as PCA and t-SNE. Visualize transformed data and analyze feature extraction performance.

#### **Lab 12: Gaussian Mixture Models (GMM)**

Implement Gaussian Mixture Models for probabilistic clustering. Analyze soft clustering behavior and compare with traditional clustering techniques.

#### **Lab 13: Hidden Markov Models (HMM) and Anomaly Detection**

Implement Hidden Markov Models for sequential data analysis. Apply anomaly detection techniques and analyze unusual patterns in datasets.

#### **Lab 14: Feature Engineering and Handling Imbalanced Data**

Perform feature engineering and feature selection techniques. Handle imbalanced datasets using SMOTE and resampling methods to improve model performance.

#### **Lab 15: Mini Project – Advanced Machine Learning Application**

Develop an end-to-end advanced machine learning solution using supervised, ensemble, clustering, or probabilistic learning techniques. Apply preprocessing, optimization, and evaluation on real-world datasets and present insights.

#### **Targeted Applications & Tools:**

|                                        |                                                                                                                                                         |
|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Python (NumPy, pandas)</b>          | Data preprocessing, analysis, and numerical computation.                                                                                                |
| <b>XGBoost, LightGBM</b>               | Advanced boosting techniques for high-performance models                                                                                                |
| <b>Scikit-learn</b>                    | Implementation of machine learning algorithms and evaluation.                                                                                           |
| <b>Matplotlib / Seaborn</b>            | Data visualization and model analysis                                                                                                                   |
| <b>Jupyter Notebook / Google Colab</b> | Interactive environments for implementing, testing, and documenting machine learning experiments with built-in visualization and hardware acceleration. |

#### **Skill-Building Activities through Experiential Learning:**

- **Model Development:**  
Students implement advanced supervised learning models such as SVM and ensemble methods.
- **Ensemble Learning Projects:**  
Learners build Random Forest, AdaBoost, and Gradient Boosting models for real-world datasets.
- **Clustering and Dimensionality Reduction:**  
Students apply clustering and PCA techniques for data exploration.
- **Model Optimization:**  
Learners perform hyperparameter tuning and improve model performance..

#### **Textbooks**

**T1:** Kevin P. Murphy – *Machine Learning: A Probabilistic Perspective*, MIT Press

**T2:** Trevor Hastie, Robert Tibshirani, Jerome Friedman – *The Elements of Statistical Learning*, Springer

#### **References**

**R1:** Aurélien Géron – *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly

|                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                      |                       |
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| R2: Christopher M. Bishop – Pattern Recognition and Machine Learning, Springer                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                      |                       |
| E-Resources/Web Resources                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                      |                       |
| 1. <a href="https://scikit-learn.org">https://scikit-learn.org</a>                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                      |                       |
| 2. <a href="https://xgboost.ai">https://xgboost.ai</a>                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                      |                       |
| 3. <a href="https://lightgbm.readthedocs.io">https://lightgbm.readthedocs.io</a>                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                      |                       |
| Course Code: ADS3401                                                                                                                                                                                                                                                        | Course Name: Deep Reinforcement Learning<br>Type of Course: Elective Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | L- T-P- C                                                            | 2-0-2-3               |
| Version No.                                                                                                                                                                                                                                                                 | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                      |                       |
| NCrF Level                                                                                                                                                                                                                                                                  | 6.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                      |                       |
| Course Pre-requisites                                                                                                                                                                                                                                                       | Machine Learning for Intelligent Data Science; Advanced Machine Learning; Linear Algebra; Probability and Statistics; Deep Learning Fundamentals; Computational Thinking using Python                                                                                                                                                                                                                                                                                                                                                                           |                                                                      |                       |
| Co-requisites                                                                                                                                                                                                                                                               | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                      |                       |
| Anti-requisites                                                                                                                                                                                                                                                             | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                      |                       |
| Course Description                                                                                                                                                                                                                                                          | This course focuses on deep reinforcement learning techniques for solving sequential decision-making problems in complex environments. It combines reinforcement learning principles with deep neural networks to handle high-dimensional state and action spaces. Topics include value-based and policy-based methods, deep Q-networks, actor-critic models, and advanced exploration strategies. Students will gain practical experience in implementing intelligent agents for real-world applications such as robotics, gaming, and recommendation systems. |                                                                      |                       |
| Course Objective                                                                                                                                                                                                                                                            | This course aims to equip learners with the knowledge and skills required to design, implement, and evaluate deep reinforcement learning models for intelligent decision-making systems.                                                                                                                                                                                                                                                                                                                                                                        |                                                                      |                       |
| Course Outcomes                                                                                                                                                                                                                                                             | On successful completion of the course the students shall be able to:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                      |                       |
|                                                                                                                                                                                                                                                                             | C01: Explain core concepts of reinforcement learning and deep reinforcement learning architectures.                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                      | [Level 2- Understand] |
|                                                                                                                                                                                                                                                                             | C02: Apply value-based and policy-based reinforcement learning algorithms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                      | [Level 3- Apply]      |
|                                                                                                                                                                                                                                                                             | C03: Analyze performance and stability of deep reinforcement learning models.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                      | [Level 4- Analyze]    |
|                                                                                                                                                                                                                                                                             | C04: Analyze reinforcement learning models using advanced techniques and interpret agent behaviour. (Analyze)                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                      | [Level 4- Analyze]    |
| Course Outcomes                                                                                                                                                                                                                                                             | C05: Analyze intelligent agents for complex real-world environments. (Analyze)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                      | [Level 4- Analyze]    |
|                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                      |                       |
| Course Content:                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                      |                       |
| Module 1                                                                                                                                                                                                                                                                    | Reinforcement Learning Foundation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Assessment: Assignment (Classical Reinforcement Learning Algorithms) | 6Sessions             |
| Introduction to Reinforcement Learning; Markov Decision Processes (MDP); Bellman equations; Policies and value functions; Exploration vs exploitation; Dynamic Programming methods; Monte Carlo methods; Temporal Difference learning; Limitations of classical RL methods. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                      |                       |
| Module 2                                                                                                                                                                                                                                                                    | Value-Based Deep Reinforcement Learning                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Assessment: Programming Assignment (Deep Q-Network                   | 6Sessions             |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                  |                                                                                       |                   |
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| Introduction to deep reinforcement learning; Deep Q-Networks (DQN); Experience Replay; Target Networks; Double DQN; Dueling DQN; Stability issues in deep RL; Implementation using deep learning frameworks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                  |                                                                                       |                   |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Advanced Value-Based Methods</b>              | <b>Assessment: Assignment (Advanced DQN Variants and Evaluation)</b>                  | <b>6 Sessions</b> |
| Prioritized Experience Replay; Improvements in DQN; Exploration strategies (epsilon-greedy, softmax); Hyperparameter tuning; Performance evaluation of RL agents; Practical implementation of value-based models.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                  |                                                                                       |                   |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Policy Gradient and Actor-Critic Methods</b>  | <b>Assessment: Programming Assignment (Policy Gradient and PPO Models)</b>            | <b>6 Sessions</b> |
| Policy Gradient Theorem; REINFORCE algorithm; Actor-Critic architecture; Advantage Actor-Critic (A2C, A3C); Proximal Policy Optimization (PPO); Deterministic Policy Gradient (DPG); Exploration in policy-based methods.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                  |                                                                                       |                   |
| <b>Module 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Advanced Deep RL Applications and Systems</b> | <b>Assessment: Mini Project (Deep Reinforcement Learning Application Development)</b> | <b>6 Sessions</b> |
| Multi-agent reinforcement learning; Deep RL in robotics and control; Reinforcement learning in recommendation systems; Model-based RL; Transfer learning in RL; Safe RL and ethical considerations; Case studies.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                  |                                                                                       |                   |
| <b>Lab Sheets:</b><br><b>1. Introduction to OpenAI Gym Environment</b><br><b>Objective:</b><br>To understand reinforcement learning environments and interact with them using OpenAI Gym.<br><b>Description:</b><br>This experiment introduces simulation environments used in reinforcement learning. Students learn how agents interact with environments through states, actions, and rewards. Using OpenAI Gym, learners explore standard environments such as Cart Pole and understand episode-based learning.<br><b>Tasks:</b> <ul style="list-style-type: none"> <li>• Install Gym/Gymnasium environment</li> <li>• Load Cart Pole environment</li> <li>• Perform random actions</li> <li>• Observe states, rewards, and termination conditions</li> </ul> <b>2. Implementation of Multi-Armed Bandit Problem</b><br><b>Objective:</b><br>To implement and analyze exploration vs exploitation strategies.<br><b>Description:</b><br>This experiment focuses on the multi-armed bandit problem, a simplified reinforcement learning setting. Students implement epsilon-greedy strategy to balance exploration and exploitation and evaluate performance over time.<br><b>Tasks:</b> <ul style="list-style-type: none"> <li>• Implement epsilon-greedy algorithm</li> <li>• Simulate multiple bandit arms</li> <li>• Track rewards over iterations</li> <li>• Compare exploration strategies</li> </ul> <b>3. Markov Decision Process (MDP) Simulation</b><br><b>Objective:</b><br>To model decision-making problems using MDP concepts. |                                                  |                                                                                       |                   |

**Description:**

Students learn how to represent environments as Markov Decision Processes. The experiment involves defining states, actions, rewards, and transition probabilities to simulate simple decision-making problems.

**Tasks:**

- Define states, actions, and rewards
- Create transition probability model
- Simulate agent decisions
- Analyze reward outcomes

**4. Value Iteration Algorithm****Objective:**

To implement value iteration for optimal policy computation.

**Description:**

This experiment introduces dynamic programming methods in reinforcement learning. Students implement value iteration to compute optimal value functions and derive policies for a given MDP.

**Tasks:**

- Initialize value function
- Apply Bellman update equation
- Iterate until convergence
- Extract optimal policy

**5. Q-Learning Algorithm****Objective:**

To implement model-free reinforcement learning using Q-learning.

**Description:**

Students implement the Q-learning algorithm, which learns optimal action-value functions without knowing environment dynamics. This experiment emphasizes learning through interaction.

**Tasks:**

- Initialize Q-table
- Implement Q-learning update rule
- Train agent in environment
- Evaluate learned policy

**6. Deep Q-Network (DQN) Implementation****Objective:**

To implement Deep Q-Network using neural networks.

**Description:**

This experiment introduces deep reinforcement learning by combining Q-learning with neural networks. Students use frameworks like TensorFlow or PyTorch to approximate Q-values.

**Tasks:**

- Build neural network model
- Implement DQN algorithm
- Train agent in Cart Pole environment
- Analyze performance

**7. Experience Replay and Target Networks****Objective:**

To improve stability of DQN using replay memory.

**Description:**

Students enhance DQN by implementing experience replay and target networks. These techniques improve training stability and reduce correlations in data.

**Tasks:**

- Implement replay buffer

- Sample mini-batches
- Use target network for updates
- Compare performance with basic DQN

### 8. Policy Gradient (REINFORCE Algorithm)

#### Objective:

To implement policy-based reinforcement learning.

#### Description:

This experiment focuses on policy gradient methods where the policy is directly optimized. Students implement REINFORCE algorithm for learning optimal policies.

#### Tasks:

- Define policy network
- Compute reward-based gradients
- Update policy parameters
- Evaluate agent performance

### 9. Actor-Critic Method Implementation

#### Objective:

To implement Actor-Critic reinforcement learning architecture.

#### Description:

This experiment introduces Actor-Critic methods that combine value-based and policy-based learning. Students implement separate actor and critic networks to improve learning efficiency and stability in reinforcement learning tasks.

### 10. Reinforcement Learning Mini Project

#### Objective:

To develop an end-to-end reinforcement learning application.

#### Description:

Students apply reinforcement learning concepts and algorithms to solve a practical problem such as game playing, path planning, or resource optimization. The project integrates environment interaction, training, evaluation, and performance analysis.

#### Targeted Applications & Tools:

|                                        |                                                                                                                                                         |
|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Python (NumPy, pandas)</b>          | Data preprocessing, analysis, and numerical computation.                                                                                                |
| <b>TensorFlow and PyTorch</b>          | Building and training deep learning models such as CNNs and neural networks. Flexible deep learning framework for research and experimentation.         |
| <b>OpenAI Gym / Gymnasium</b>          | Simulation environments for training RL agents                                                                                                          |
| <b>Stable-Baselines3</b>               | Pre-built implementations of RL algorithms                                                                                                              |
| <b>Matplotlib / Seaborn</b>            | Visualization of learning performance                                                                                                                   |
| <b>Jupyter Notebook / Google Colab</b> | Interactive environments for implementing, testing, and documenting machine learning experiments with built-in visualization and hardware acceleration. |

#### Skill-Building Activities through Experiential Learning:

- **RL Agent Development:**  
Students build agents using Q-learning and Deep Q-Networks
- **Policy Optimization Projects:**  
Learners implement policy gradient and actor-critic algorithms
- **Simulation-Based Learning:**  
Training agents in environments like CartPole, MountainCar
- **Real-World Applications:**  
Applying RL in robotics, games, and recommendation systems

#### Textbooks

|                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>T1:</b> Richard S. Sutton and Andrew G. Barto – <i>Reinforcement Learning: An Introduction</i> , MIT Press<br><b>T2:</b> Maxim Lapan – <i>Deep Reinforcement Learning Hands-On</i> , Packt Publishing                                                                                                                                                          |
| <b>References</b><br><b>R1:</b> Ian Goodfellow, Yoshua Bengio, Aaron Courville – <i>Deep Learning</i> , MIT Press<br><b>R2:</b> Aurélien Géron – <i>Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow</i> , O'Reilly<br><b>R3:</b> David Silver – <i>Reinforcement Learning Lectures</i> , UCL                                                   |
| <b>E-Resources/Web Resources</b> <ol style="list-style-type: none"> <li><a href="https://onlinecourses.nptel.ac.in/noc25_cs62/preview?utm_source=chatgpt.com">https://onlinecourses.nptel.ac.in/noc25_cs62/preview?utm_source=chatgpt.com</a></li> <li><a href="https://stable-baselines3.readthedocs.io">https://stable-baselines3.readthedocs.io</a></li> </ol> |

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|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|---------|
| <b>Course Code:</b><br>ADS3402 | <b>Course Name:</b> Generative AI and Large Language Models<br><b>Type of Course:</b> Elective Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>L- T-P- C</b> | 2-0-2-3 |
| <b>Version No.</b>             | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                  |         |
| <b>NCrF Level</b>              | 6.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                  |         |
| <b>Course Pre-requisites</b>   | Machine Learning for Intelligent Data Science; Basic Deep Learning; Natural Language Processing Basics; Probability and Statistics; Computational Thinking using Python                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                  |         |
| <b>Co-requisites</b>           | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                  |         |
| <b>Anti-requisites</b>         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                  |         |
| <b>Course Description</b>      | This course introduces the fundamentals of Generative AI and Large Language Models (LLMs) with a focus on practical understanding and applications. It covers basic concepts of text generation, transformer models, prompt engineering, and usage of pre-trained models. Students will learn how to use modern tools and APIs to build intelligent applications such as chatbots, text summarizers, and AI assistants.                                                                                                                                                                                                             |                  |         |
| <b>Course Objective</b>        | This course aims to equip students with the knowledge and practical skills required to understand and use generative AI and large language models for real-world applications.                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                  |         |
| <b>Course Outcomes</b>         | On successful completion of the course the students shall be able to: <p><b>C01:</b> Explain the basic concepts of generative AI and large language models. [Level 2- Understand]</p> <p><b>C02:</b> Apply transformer-based models for simple text generation tasks. [Level 3- Apply]</p> <p><b>C03:</b> Analyze outputs and limitations of large language models. [Level 4- Analyze]</p> <p><b>C04:</b> Analyze applications developed using generative AI tools and APIs. [Level 4- Analyze]</p> <p>(Analyze) [Level 4- Analyze]</p> <p><b>C05:</b> Analyze Models Output using Prompt Engineering and validation techniques</p> |                  |         |
| <b>Course Content:</b>         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                  |         |

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| <b>Module 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Foundations of Generative AI</b>            | <b>Assessment: Assignment (Language Modeling and Text Generation Basics)</b>            | <b>6Sessions</b>  |
| Introduction to Artificial Intelligence and Generative AI; Discriminative vs Generative models; Probability-based generation; Language modeling basics; N-grams; Neural language models; Evaluation metrics (Perplexity, BLEU score – basic idea); Applications of Generative AI.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                |                                                                                         |                   |
| <b>Module 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Transformer Models and LLM Architecture</b> | <b>Assessment: Quiz + Assignment (Transformer Models using Hugging Face/TensorFlow)</b> | <b>6Sessions</b>  |
| Limitations of traditional models; Attention mechanism; Self-attention; Transformer architecture; Encoder-Decoder models; Positional encoding; Tokenization techniques; Overview of BERT and GPT models; Pre-training and fine-tuning concepts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                |                                                                                         |                   |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Working with Large Language Models</b>      | <b>Assessment: Programming Assignment (Prompt Engineering and LLM APIs)</b>             | <b>6Sessions</b>  |
| Prompt engineering (zero-shot, few-shot learning); Instruction tuning; Introduction to LLM APIs; Fine-tuning methods (basic idea – LoRA, adapters); Evaluation of LLM outputs; Performance metrics; Practical usage of LLMs.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                |                                                                                         |                   |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Advanced LLM Techniques</b>                 | <b>Assessment: Assignment (RAG and Responsible AI Techniques)</b>                       | <b>6Sessions</b>  |
| Retrieval-Augmented Generation (RAG); Hallucination issues and mitigation; Scaling laws (overview); Responsible AI and ethical considerations; Safety in LLMs; Model limitations and challenges.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                |                                                                                         |                   |
| <b>Module 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Applications of Generative AI</b>           | <b>Assessment: Mini Project (Generative AI Application Development)</b>                 | <b>6 Sessions</b> |
| Text generation and summarization; Chatbots and conversational AI; Code generation; Introduction to multimodal models; Diffusion models (overview); Applications in healthcare, finance, education; Case studies and real-world deployments.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                |                                                                                         |                   |
| <b>Lab Sheets:</b><br><b>1. Introduction to Hugging Face Transformers</b><br><b>Objective:</b><br>To understand and use pre-trained transformer models for basic NLP tasks.<br><b>Description:</b><br>This experiment introduces the Hugging Face Transformers library for working with pre-trained models. Students learn how to load models such as BERT and GPT and perform simple tasks like text classification and generation. It helps in understanding how LLMs can be used without training from scratch.<br><b>Tasks:</b> <ul style="list-style-type: none"> <li>• Install transformers and required libraries</li> <li>• Load a pre-trained model</li> <li>• Perform text classification or generation</li> <li>• Analyze model output</li> </ul> <b>2.Text Generation using GPT Models</b><br><b>Objective:</b><br>To generate text using pre-trained GPT models.<br><b>Description:</b><br>Students use GPT-based models to generate coherent text from prompts. The experiment focuses on understanding how input prompts influence generated outputs and how parameters affect generation quality.<br><b>Tasks:</b> <ul style="list-style-type: none"> <li>• Load GPT model</li> <li>• Provide input prompts</li> </ul> |                                                |                                                                                         |                   |

- Generate text outputs
- Experiment with parameters (max length, temperature)

### **3. Text Summarization using Transformers**

#### **Objective:**

To perform automatic text summarization using LLMs.

#### **Description:**

This experiment demonstrates how transformer models can summarize large text into concise summaries. Students explore extractive and abstractive summarization techniques.

#### **Tasks:**

- Load summarization model
- Input long text
- Generate summary
- Compare outputs for different inputs

### **4. Prompt Engineering Techniques**

#### **Objective:**

To design effective prompts for improving LLM outputs.

#### **Description:**

Students explore prompt engineering techniques such as zero-shot and few-shot prompting. The experiment highlights how prompt design affects model performance.

#### **Tasks:**

- Create zero-shot prompts
- Create few-shot prompts
- Compare outputs
- Analyze effectiveness of prompts

### **5. Chatbot Development using LLM APIs**

#### **Objective:**

To build a simple chatbot using LLM APIs.

#### **Description:**

This experiment introduces API-based usage of large language models. Students build a chatbot capable of answering queries using pre-trained LLM services.

#### **Tasks:**

- Set up API access
- Design chatbot interface
- Send user queries to model
- Display responses

### **6. Sentiment Analysis using BERT**

#### **Objective:**

To classify text sentiment using transformer models.

#### **Description:**

Students use BERT-based models to analyze sentiment in text data. This demonstrates practical application of LLMs in classification tasks.

#### **Tasks:**

- Load sentiment analysis model
- Input text samples
- Classify sentiment
- Evaluate predictions

### **7. Named Entity Recognition (NER)**

#### **Objective:**

To extract entities from text using LLMs.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Description:</b><br>This experiment focuses on identifying entities such as names, locations, and organizations using transformer-based models.                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                         |
| <b>Tasks:</b> <ul style="list-style-type: none"> <li>• Load NER model</li> <li>• Input text</li> <li>• Extract entities</li> <li>• Display results</li> </ul>                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                         |
| <b>Targeted Applications &amp; Tools:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                         |
| <b>Python (NumPy, pandas)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Data preprocessing, analysis, and numerical computation.                                                                                                |
| <b>Hugging Face Transformers</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Using pre-trained language models                                                                                                                       |
| <b>OpenAI API / LLM APIs</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Building applications with LLMs                                                                                                                         |
| <b>LangChain (Basic)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Developing LLM-based applications                                                                                                                       |
| <b>Jupyter Notebook / Google Colab</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Interactive environments for implementing, testing, and documenting machine learning experiments with built-in visualization and hardware acceleration. |
| <b>Skill-Building Activities through Experiential Learning:</b> <ul style="list-style-type: none"> <li>• <b>LLM-Based Application Development:</b><br/>Students build simple chatbot and text generation applications</li> <li>• <b>Prompt Engineering Practice:</b><br/>Designing effective prompts for different use cases</li> <li>• <b>Text Processing Tasks:</b><br/>Perform summarization and content generation</li> <li>• <b>Mini Project:</b><br/>Develop a small real-world application using LLM APIs</li> </ul> |                                                                                                                                                         |
| <b>Textbooks</b><br><b>T1:</b> Jurafsky & Martin – <i>Speech and Language Processing</i><br><b>T2:</b> Lewis Tunstall et al. – <i>Natural Language Processing with Transformers</i> , O'Reilly                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                         |
| <b>References:</b><br>R1: Ian Goodfellow et al. – <i>Deep Learning</i> , MIT Press<br>R2: Ashish Vaswani et al. – <i>Attention is All You Need</i><br>R3: OpenAI Documentation – Generative AI Guides                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                         |
| <b>E-Resources/Web Resources</b> <ol style="list-style-type: none"> <li>1. <a href="#">Introduction to Large Language Models (NPTEL)</a></li> <li>2. <a href="#">Generative AI with Large Language Models (DeepLearning.AI)</a></li> </ol>                                                                                                                                                                                                                                                                                  |                                                                                                                                                         |

|                                      |                                                                                                                     |                  |         |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------------|------------------|---------|
| <b>Course Code:</b><br>ADS3403       | <b>Course Name:</b> Knowledge Representation and Reasoning<br><b>Type of Course:</b> Elective Course                | <b>L- T-P- C</b> | 2-0-2-3 |
| <b>Version No.</b>                   | 1.0                                                                                                                 |                  |         |
| <b>NCrF Level</b>                    | 6.0                                                                                                                 |                  |         |
| <b>Course requisites</b> <b>Pre-</b> | Introduction to Artificial Intelligence; Discrete Mathematics; Basics of Logic; Computational Thinking using Python |                  |         |
| <b>Co-requisites</b>                 | NIL                                                                                                                 |                  |         |

|                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                             |            |                                                                                  |             |           |                                                                                   |  |                  |                                                                       |          |           |                                                             |          |           |                                                                            |  |           |  |          |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|------------|----------------------------------------------------------------------------------|-------------|-----------|-----------------------------------------------------------------------------------|--|------------------|-----------------------------------------------------------------------|----------|-----------|-------------------------------------------------------------|----------|-----------|----------------------------------------------------------------------------|--|-----------|--|----------|--|
| Anti-requisites                                                                                                                                                                                                                        | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                             |            |                                                                                  |             |           |                                                                                   |  |                  |                                                                       |          |           |                                                             |          |           |                                                                            |  |           |  |          |  |
| Course Description                                                                                                                                                                                                                     | This course introduces the principles of knowledge representation and reasoning in artificial intelligence. It focuses on logic-based representation, inference mechanisms, and structured knowledge models such as semantic networks and ontologies. The course also covers rule-based systems, expert systems, and reasoning under uncertainty, providing a strong foundation for building intelligent systems.                                                                                                                                                                                                                                                                                                                                                                      |                                                                             |            |                                                                                  |             |           |                                                                                   |  |                  |                                                                       |          |           |                                                             |          |           |                                                                            |  |           |  |          |  |
| Course Objective                                                                                                                                                                                                                       | To enable students to represent knowledge formally and apply reasoning techniques to solve AI problems effectively.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                             |            |                                                                                  |             |           |                                                                                   |  |                  |                                                                       |          |           |                                                             |          |           |                                                                            |  |           |  |          |  |
| Course Outcomes                                                                                                                                                                                                                        | <p>On successful completion of the course the students shall be able to:</p> <table><tr><td><b>C01:</b> Explain knowledge representation techniques and logical foundations.</td><td>Understand]</td><td>[Level 2-</td></tr><tr><td><b>C02:</b> Apply propositional and predicate logic for knowledge representation.</td><td></td><td>[Level 3- Apply]</td></tr><tr><td><b>C03:</b> Analyze inference and reasoning mechanisms in AI systems.</td><td>Analyze]</td><td>[Level 4-</td></tr><tr><td><b>C04:</b> Analyze rule-based and knowledge-based systems.</td><td>Analyze]</td><td>[Level 4-</td></tr><tr><td><b>C05:</b> Analyze Different reasoning approaches and their Applications.</td><td></td><td>[Level 4-</td></tr><tr><td></td><td>Analyze]</td><td></td></tr></table> |                                                                             |            | <b>C01:</b> Explain knowledge representation techniques and logical foundations. | Understand] | [Level 2- | <b>C02:</b> Apply propositional and predicate logic for knowledge representation. |  | [Level 3- Apply] | <b>C03:</b> Analyze inference and reasoning mechanisms in AI systems. | Analyze] | [Level 4- | <b>C04:</b> Analyze rule-based and knowledge-based systems. | Analyze] | [Level 4- | <b>C05:</b> Analyze Different reasoning approaches and their Applications. |  | [Level 4- |  | Analyze] |  |
| <b>C01:</b> Explain knowledge representation techniques and logical foundations.                                                                                                                                                       | Understand]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | [Level 2-                                                                   |            |                                                                                  |             |           |                                                                                   |  |                  |                                                                       |          |           |                                                             |          |           |                                                                            |  |           |  |          |  |
| <b>C02:</b> Apply propositional and predicate logic for knowledge representation.                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | [Level 3- Apply]                                                            |            |                                                                                  |             |           |                                                                                   |  |                  |                                                                       |          |           |                                                             |          |           |                                                                            |  |           |  |          |  |
| <b>C03:</b> Analyze inference and reasoning mechanisms in AI systems.                                                                                                                                                                  | Analyze]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | [Level 4-                                                                   |            |                                                                                  |             |           |                                                                                   |  |                  |                                                                       |          |           |                                                             |          |           |                                                                            |  |           |  |          |  |
| <b>C04:</b> Analyze rule-based and knowledge-based systems.                                                                                                                                                                            | Analyze]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | [Level 4-                                                                   |            |                                                                                  |             |           |                                                                                   |  |                  |                                                                       |          |           |                                                             |          |           |                                                                            |  |           |  |          |  |
| <b>C05:</b> Analyze Different reasoning approaches and their Applications.                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | [Level 4-                                                                   |            |                                                                                  |             |           |                                                                                   |  |                  |                                                                       |          |           |                                                             |          |           |                                                                            |  |           |  |          |  |
|                                                                                                                                                                                                                                        | Analyze]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                             |            |                                                                                  |             |           |                                                                                   |  |                  |                                                                       |          |           |                                                             |          |           |                                                                            |  |           |  |          |  |
| Course Content:                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                             |            |                                                                                  |             |           |                                                                                   |  |                  |                                                                       |          |           |                                                             |          |           |                                                                            |  |           |  |          |  |
| Module 1                                                                                                                                                                                                                               | Introduction to Knowledge Representation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Assessment: Assignment (Knowledge Representation Techniques and Case Study) | 6Sessions  |                                                                                  |             |           |                                                                                   |  |                  |                                                                       |          |           |                                                             |          |           |                                                                            |  |           |  |          |  |
| Introduction to Artificial Intelligence and Knowledge Representation; Types of knowledge; Issues in knowledge representation; Semantic networks; Frames (basic idea); Conceptual dependency; Applications of knowledge representation. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                             |            |                                                                                  |             |           |                                                                                   |  |                  |                                                                       |          |           |                                                             |          |           |                                                                            |  |           |  |          |  |
| Module 2                                                                                                                                                                                                                               | Propositional Logic and Reasoning                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Assessment: Quiz + Assignment (Logic and Reasoning Problems)                | 6Sessions  |                                                                                  |             |           |                                                                                   |  |                  |                                                                       |          |           |                                                             |          |           |                                                                            |  |           |  |          |  |
| Propositional logic – syntax and semantics; Logical connectives; Truth tables; Inference rules; Entailment; Normal forms (CNF, DNF – basic idea); Resolution method; Problem-solving using propositional logic.                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                             |            |                                                                                  |             |           |                                                                                   |  |                  |                                                                       |          |           |                                                             |          |           |                                                                            |  |           |  |          |  |
| Module 3                                                                                                                                                                                                                               | First Order Logic and Inference Techniques                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Assessment: Programming Assignment (FOL and Resolution Methods)             | 6Sessions  |                                                                                  |             |           |                                                                                   |  |                  |                                                                       |          |           |                                                             |          |           |                                                                            |  |           |  |          |  |
| Predicate logic (First Order Logic); Syntax and semantics; Quantifiers; Representation using FOL; Unification algorithm; Skolemization; Conversion to CNF; Resolution in FOL; Logical reasoning examples.                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                             |            |                                                                                  |             |           |                                                                                   |  |                  |                                                                       |          |           |                                                             |          |           |                                                                            |  |           |  |          |  |
| Module 4                                                                                                                                                                                                                               | Rule-Based Systems and Logic Programming                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Assessment: Assignment (Rule-Based Systems and Prolog Programming)          | 6Sessions  |                                                                                  |             |           |                                                                                   |  |                  |                                                                       |          |           |                                                             |          |           |                                                                            |  |           |  |          |  |
| Expert systems; Rule-based systems; Forward chaining and backward chaining; Production systems; Inference engines; Introduction to Prolog; Writing simple Prolog programs; Applications of rule-based reasoning.                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                             |            |                                                                                  |             |           |                                                                                   |  |                  |                                                                       |          |           |                                                             |          |           |                                                                            |  |           |  |          |  |
| Module 5                                                                                                                                                                                                                               | Advanced Knowledge Representation and Applications                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Assessment: Mini Project (Knowledge-Based System Development)               | 6 Sessions |                                                                                  |             |           |                                                                                   |  |                  |                                                                       |          |           |                                                             |          |           |                                                                            |  |           |  |          |  |
| Ontologies and semantic web; Description logics (overview); Knowledge graphs; Non-monotonic reasoning; Default reasoning; Reasoning under uncertainty; Applications and case studies.                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                             |            |                                                                                  |             |           |                                                                                   |  |                  |                                                                       |          |           |                                                             |          |           |                                                                            |  |           |  |          |  |

**Labsheets:****1. Basic Prolog Programming****Objective:**

To understand the fundamentals of Prolog programming and implement basic facts and rules.

**Description:**

This experiment introduces Prolog as a declarative programming language used in Artificial Intelligence. Students learn how to define facts and rules to represent knowledge. The experiment focuses on logical inference, where queries are executed to derive conclusions based on the knowledge base. It helps students understand how Prolog uses automatic reasoning.

**Tasks:**

- Install and set up Prolog environment (SWI-Prolog).
- Define simple facts and rules.
- Execute queries to retrieve information.
- Understand logical inference mechanism in Prolog.

**2. Family Tree Representation****Objective:**

To represent and query family relationships using Prolog.

**Description:**

This experiment focuses on modeling real-world family relationships using logical facts and rules. Students define relationships such as parent-child and derive complex relationships like sibling, grandparent, ancestor, and cousin. It helps in understanding hierarchical knowledge representation and reasoning.

**Tasks:**

- Define family relationship facts (parent, male, female).
- Write rules for sibling, grandparent, ancestor, and cousin.
- Execute queries to find relationships between individuals.
- Analyze hierarchical inference.

**3. Logical Operations using Prolog****Objective:**

To implement logical operations such as AND, OR, and NOT using Prolog rules.

**Description:**

This experiment demonstrates how Boolean logic can be represented using Prolog predicates. Students implement logical operations using rules and evaluate compound logical expressions. It helps in understanding logical reasoning and truth evaluation in AI systems.

**Tasks:**

- Define rules for AND, OR, NOT operations.
- Evaluate logical expressions using queries.
- Test different combinations of Boolean inputs.
- Understand rule-based logical evaluation.

**4. Forward Chaining****Objective:**

To implement a rule-based inference system using forward chaining.

**Description:**

This experiment focuses on data-driven reasoning. Starting from known facts, rules are applied to derive new facts until a conclusion is reached. It helps students understand how inference engines derive knowledge automatically.

**Tasks:**

- Define initial facts and inference rules.

- Apply forward chaining mechanism.
- Derive new facts step-by-step.
- Trace inference process.

### **5. Backward Chaining**

#### **Objective:**

To implement goal-driven reasoning using backward chaining.

#### **Description:**

This experiment demonstrates backward reasoning where a goal is given and the system checks whether it can be satisfied using existing facts and rules. It helps students understand query-driven inference used in Prolog.

#### **Tasks:**

- Define facts and rules.
- Set goal queries.
- Trace backward reasoning steps.
- Verify goal satisfaction using inference.

### **6. Water Jug Problem**

#### **Objective:**

To solve the Water Jug problem using state-space representation in Prolog.

#### **Description:**

This experiment involves solving a classical AI problem using search techniques. Students define states, transitions, and goal conditions. The system explores possible state transitions to reach the desired water measurement.

#### **Tasks:**

- Define state representation of jugs.
- Define rules for pouring and filling water.
- Implement goal state condition.
- Find solution path using search.

### **7. Tower of Hanoi**

#### **Objective:**

To implement Tower of Hanoi problem using recursion in Prolog.

#### **Description:**

This experiment demonstrates recursive problem solving. The Tower of Hanoi problem is solved by breaking it into smaller subproblems using logical rules. It helps students understand recursion in AI problem solving.

#### **Tasks:**

- Define recursive rules for disk movement.
- Specify source, auxiliary, and destination rods.
- Implement base and recursive cases.
- Display solution steps.

### **8. Expert System Development**

#### **Objective:**

To design a simple rule-based expert system using Prolog.

#### **Description:**

This experiment focuses on building an expert system using IF-THEN rules. Students design systems for applications like medical diagnosis or decision-making. It demonstrates real-world AI reasoning systems.

#### **Tasks:**

- Define knowledge base using rules.
- Implement IF-THEN inference rules.
- Design a decision-making system.
- Test system with sample inputs.

## 9. Unification Algorithm

### Objective:

To understand and implement unification in Prolog.

### Description:

This experiment focuses on the process of matching logical expressions using variable substitution. Students learn how Prolog performs pattern matching and resolves variables during inference.

### Tasks:

- Define logical expressions with variables.
- Perform unification between terms.
- Analyze variable substitution results.
- Understand matching process in Prolog.

## 10. Resolution Method

### Objective:

To apply the resolution principle for logical inference.

### Description:

This experiment demonstrates automated theorem proving using resolution. Students convert statements into clause form and apply resolution rules to derive conclusions logically.

### Tasks:

- Convert expressions into clause form.
- Apply resolution rule step-by-step.
- Derive conclusions from given statements.
- Analyze logical proof process.

### Targeted Applications & Tools:

|                        |                                                          |
|------------------------|----------------------------------------------------------|
| Python (NumPy, pandas) | Data preprocessing, analysis, and numerical computation. |
| Prolog                 | Logic programming and reasoning                          |
| Protégé                | Ontology modeling                                        |
| Graph-based Tools      | Knowledge graph representation                           |

### Skill-Building Activities through Experiential Learning:

- Logic Representation:  
Students solve problems using propositional and predicate logic
- Inference System Design:  
Implement forward and backward chaining
- Prolog Programming:  
Write basic logic programs
- Mini Project:  
Develop a simple expert system

### Textbooks

**T1:** Stuart Russell & Peter Norvig – *Artificial Intelligence: A Modern Approach*, Pearson

**T2:** Ronald Brachman & Hector Levesque – *Knowledge Representation and Reasoning*, Morgan Kaufmann

### References:

- **R1:** Ivan Bratko – *Prolog Programming for Artificial Intelligence*
- **R2:** George F. Luger – *Artificial Intelligence: Structures and Strategies*
- **R3:** Grigoris Antoniou & Frank van Harmelen – *A Semantic Web Primer*

### E-Resources/Web Resources

3. <https://nptel.ac.in/courses/106106140>
4. <https://www.geeksforgeeks.org/artificial-intelligence/>

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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|------------|
| Course Code: ADS3404                                                                                                                                                                                                       | Course Name: Multi Agent System<br>Type of Course: Elective Course                                                                                                                                                                                                                                                                                                                                                                                                                                               | L- T-P- C                                                                     | 2-0-2-3    |
| Version No.                                                                                                                                                                                                                | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                               |            |
| NCrF Level                                                                                                                                                                                                                 | 6.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                               |            |
| Course Pre-requisites                                                                                                                                                                                                      | Artificial Intelligence ,Machine Learning Basics ,Python Programming ,Data Structures, Basics of Distributed Systems                                                                                                                                                                                                                                                                                                                                                                                             |                                                                               |            |
| Co-requisites                                                                                                                                                                                                              | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                               |            |
| Anti-requisites                                                                                                                                                                                                            | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                               |            |
| Course Description                                                                                                                                                                                                         | This course introduces the concepts and techniques of <b>Multi-Agent Systems (MAS)</b> , where multiple intelligent agents interact, cooperate, and compete to solve complex problems. It covers agent architectures, communication, coordination, negotiation, and real-world applications such as robotics, distributed AI, and autonomous systems.                                                                                                                                                            |                                                                               |            |
| Course Objective                                                                                                                                                                                                           | <ul style="list-style-type: none"><li>To understand the fundamentals of intelligent agents and multi-agent environments</li><li>To study coordination, cooperation, and communication among agents</li><li>To design and implement agent-based systems</li><li>To explore real-world applications of MAS</li></ul>                                                                                                                                                                                               |                                                                               |            |
| Course Outcomes                                                                                                                                                                                                            | On successful completion of the course the students shall be able to:<br><br><b>C01:</b> Explain concepts of intelligent agents and MAS. [Level 2 - Understand]<br><b>C02:</b> Apply agent architectures and communication protocols. [Level 3 – Apply]<br><b>C03:</b> Analyze coordination and negotiation strategies. [Level 4 – Analyze]<br><b>C04:</b> Analyze multi-agent systems for real-world problems. [Level 4 – Analyze]<br><b>C05:</b> Analyze performance and behaviour of MAS. [Level 3 – Analyze] |                                                                               |            |
| Course Content:                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                               |            |
| Module 1                                                                                                                                                                                                                   | Introduction to Multi-Agent Systems                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Assessment: Assignment (Agent Types and MAS Applications)                     | 6 Sessions |
| Introduction to Artificial Intelligence and Agents, Characteristics of Intelligent Agents, Types of Agents (Reactive, Deliberative, Hybrid), Single-Agent vs Multi-Agent Systems, Agent Environments, Applications of MAS. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                               |            |
| Module 2                                                                                                                                                                                                                   | Agent Architectures                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Assessment: Programming Assignment (Agent Architecture Design and Simulation) | 6 Sessions |
| Reactive architectures, Deliberative architectures, BDI (Belief-Desire-Intention) model, Hybrid architectures, Agent design methodologies, Agent development frameworks.                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                               |            |
| Module 3                                                                                                                                                                                                                   | Agent Communication                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Assessment: Quiz + Assignment (Agent Communication Protocols)                 | 6 Sessions |
| Communication in MAS, Agent Communication Languages (ACL), Knowledge Query and Manipulation Language (KQML), FIPA standards, Ontologies in MAS, Message passing and protocols.                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                               |            |
| Module 4                                                                                                                                                                                                                   | Coordination and Negotiation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Assessment: Assignment (Coordination and Negotiation Strategies in MAS)       | 6 Sessions |
| Coordination strategies, Cooperation and teamwork, Task allocation, Distributed problem solving,                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                               |            |

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| Negotiation techniques, Game theory basics in MAS.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                         |                                                                              |                   |
| <b>Module 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Advanced Topics and Applications</b> | <b>Assessment:</b> Mini Project (Multi-Agent System Application Development) | <b>6 Sessions</b> |
| warm intelligence, Multi-agent reinforcement learning (basic idea), Trust and reputation systems, Security in MAS, Applications: Robotics, Smart grids, Autonomous vehicles, E-commerce systems, Case studies.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                         |                                                                              |                   |
| <p><b>Lab sheets:</b></p> <p><b>1. Introduction to Agent-Based Modeling</b></p> <p><b>Objective:</b><br/>Understand basic agent-based simulation.</p> <p><b>Tasks:</b></p> <ul style="list-style-type: none"> <li>• Install NetLogo / Python libraries</li> <li>• Create simple agent model</li> <li>• Simulate environment interaction</li> </ul> <p><b>2. Reactive Agent Implementation</b></p> <p><b>Objective:</b><br/><b>Design a simple reactive agent.</b></p> <p><b>Tasks:</b></p> <ul style="list-style-type: none"> <li>• Define environment rules</li> <li>• Implement agent behavior</li> <li>• Test responses</li> </ul> <p><b>3. BDI Agent Design</b></p> <p><b>Objective:</b><br/>Implement BDI architecture.</p> <p><b>Tasks:</b></p> <ul style="list-style-type: none"> <li>• Define beliefs, desires, intentions</li> <li>• Simulate decision-making</li> <li>• Analyze behavior</li> </ul> <p><b>4. Agent Communication</b></p> <p><b>Objective:</b><br/>Implement communication between agents.</p> <p><b>Tasks:</b></p> <ul style="list-style-type: none"> <li>• Create multiple agents</li> <li>• Send/receive messages</li> <li>• Implement protocol</li> </ul> <p><b>5. Task Allocation in MAS</b></p> <p><b>Objective:</b><br/>Solve distributed task allocation problem.</p> <p><b>Tasks:</b></p> <ul style="list-style-type: none"> <li>• Define tasks and agents</li> <li>• Assign tasks using algorithm</li> </ul> |                                         |                                                                              |                   |

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| <ul style="list-style-type: none"><li>Evaluate efficiency</li></ul> <b>6. Negotiation Simulation</b><br><b>Objective:</b><br>Simulate negotiation between agents.<br><b>Tasks:</b> <ul style="list-style-type: none"><li>Define negotiation strategy</li><li>Implement bidding/auction</li><li>Analyze results</li></ul> |                                                                                                                            |  |               |
| <b>Targeted Applications &amp; Tools:</b>                                                                                                                                                                                                                                                                                |                                                                                                                            |  |               |
| <b>Python (NumPy, pandas)</b>                                                                                                                                                                                                                                                                                            | Used for numerical computation, discrete-event simulation, and building agent-based models in Multi-Agent Systems.         |  |               |
| <b>NetLogo</b>                                                                                                                                                                                                                                                                                                           | A simulation environment specifically designed for modelling and visualizing agent-based systems and complex interactions. |  |               |
| <b>JADE (Java Agent Development Framework)</b>                                                                                                                                                                                                                                                                           | A Java-based framework used to develop, deploy, and manage multi-agent systems with communication support.                 |  |               |
| <b>OpenAI APIs (for intelligent agents)</b>                                                                                                                                                                                                                                                                              | APIs that enable agents to use large language models for reasoning, decision-making, and natural language interaction.     |  |               |
| <b>Jupyter Notebook / Google Colab</b>                                                                                                                                                                                                                                                                                   | Interactive development environments used for writing, testing, and visualizing MAS simulations and experiments in Python. |  |               |
| <b>Skill-Building Activities through Experiential Learning:</b>                                                                                                                                                                                                                                                          |                                                                                                                            |  |               |
| <ul style="list-style-type: none"><li>Agent-based simulations</li><li>MAS design projects</li><li>Negotiation strategy development</li><li>Real-world problem modelling</li></ul>                                                                                                                                        |                                                                                                                            |  |               |
| <b>Textbooks</b><br><b>T1:</b> Michael Wooldridge, <i>An Introduction to Multi-Agent Systems</i> , Wiley Publications.<br><b>T2:</b> Artificial Intelligence: A Modern Approach – Stuart Russell and Peter Norvig, Pearson Education.                                                                                    |                                                                                                                            |  |               |
| <b>References:</b><br><b>R1:</b> Gerhard Weiss – <i>Multiagent Systems</i><br><b>R2:</b> Shoham & Leyton-Brown – <i>Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations</i>                                                                                                                         |                                                                                                                            |  |               |
| <b>E-Resources/Web Resources</b>                                                                                                                                                                                                                                                                                         |                                                                                                                            |  |               |
| 1.NetLogo                                                                                                                                                                                                                                                                                                                | Official                                                                                                                   |  | Documentation |
| <a href="https://ccl.northwestern.edu/netlogo/docs/">https://ccl.northwestern.edu/netlogo/docs/</a>                                                                                                                                                                                                                      |                                                                                                                            |  |               |
| 2.JADE (Java Agent Development Framework)                                                                                                                                                                                                                                                                                |                                                                                                                            |  | Documentation |
| <a href="https://jade.tilab.com/documentation/">https://jade.tilab.com/documentation/</a>                                                                                                                                                                                                                                |                                                                                                                            |  |               |
| 3.Mesa                                                                                                                                                                                                                                                                                                                   |                                                                                                                            |  | Documentation |
| <a href="https://mesa.readthedocs.io/">https://mesa.readthedocs.io/</a>                                                                                                                                                                                                                                                  |                                                                                                                            |  |               |
| 4.OpenAI API                                                                                                                                                                                                                                                                                                             |                                                                                                                            |  | Documentation |
| <a href="https://platform.openai.com/docs/">https://platform.openai.com/docs/</a>                                                                                                                                                                                                                                        |                                                                                                                            |  |               |
| 5.NPTEL Courses on AI & Multi-Agent Systems                                                                                                                                                                                                                                                                              |                                                                                                                            |  |               |
| <a href="https://nptel.ac.in/">https://nptel.ac.in/</a>                                                                                                                                                                                                                                                                  |                                                                                                                            |  |               |
| 6.Coursera Multi-Agent Systems & AI Courses                                                                                                                                                                                                                                                                              |                                                                                                                            |  |               |
| <a href="https://www.coursera.org/">https://www.coursera.org/</a>                                                                                                                                                                                                                                                        |                                                                                                                            |  |               |

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| <b>Course Code:</b><br>ADS3405 | <b>Course Title:</b> Big Data Analytics<br><b>Type of Course:</b> Theory Course | <b>L- T-P- C</b> | 2-0-2-3 |
| <b>Version No.</b>             | 1.0                                                                             |                  |         |
| <b>NCrF Level-</b>             | 5.0                                                                             |                  |         |

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| Course pre-requisites                                                                                                                                                                                                                                         | Data Structures and Algorithms, Database Management Systems, Introduction to Data Science                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                         |            |
| Co-requisites                                                                                                                                                                                                                                                 | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                         |            |
| Anti-requisites                                                                                                                                                                                                                                               | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                         |            |
| Course Description                                                                                                                                                                                                                                            | This course introduces the concepts and technologies of big data analytics, focusing on processing, storing, and analyzing large-scale datasets. It covers distributed computing frameworks, data processing models, and real-time analytics. Students will gain practical exposure to tools such as Hadoop, Spark, and NoSQL databases to build scalable data analytics solutions.                                                                                                                                                                                   |                                                                         |            |
| Course Objective                                                                                                                                                                                                                                              | To enable learners to process, analyze, and extract insights from large-scale datasets using big data technologies and distributed computing frameworks.                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                         |            |
| Course Outcomes                                                                                                                                                                                                                                               | <b>On successful completion of the course the students shall be able to:</b><br><br><b>C01:</b> Understand big data concepts, characteristics, and challenges.. [Level 2 – Understand]<br><b>C02:</b> Apply distributed computing frameworks for big data processing. [Level 3 – Apply]<br><b>C03:</b> Analyze large datasets using big data tools and techniques. [Level 4 – Analyze]<br><b>C04:</b> Analyze performance of big data systems and solutions. [Level 4 – Analyze]<br><b>C05:</b> Analyze scalable big data analytics applications. [Level 4 – Analyze] |                                                                         |            |
| Course Content:                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                         |            |
| Module 1                                                                                                                                                                                                                                                      | Introduction to Big Data and Analytics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Assessment: Assignment (Big Data Concepts and Applications)             | 6 Sessions |
| Introduction to Big Data – Characteristics of Big Data (Volume, Velocity, Variety, Veracity, Value) – Traditional vs Big Data Systems – Challenges in big data processing – Applications of big data in AI and Data Science – Big data architecture overview. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                         |            |
| Module 2                                                                                                                                                                                                                                                      | Distributed Computing and Hadoop Ecosystem                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Assessment: Quiz + Assignment (Hadoop and Distributed Computing Basics) | 6 Sessions |
| Distributed computing concepts – Hadoop architecture – Hadoop Distributed File System (HDFS) – MapReduce programming model – YARN resource management – Overview of Hadoop ecosystem tools.                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                         |            |
| Module 3                                                                                                                                                                                                                                                      | Apache Spark and Data Processing                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Assessment: Programming Assignment (Apache Spark using PySpark)         | 6 Sessions |
| Introduction to Apache Spark – Spark architecture – Resilient Distributed Datasets (RDDs) – Data Frames and Spark SQL – Spark for batch and stream processing – Performance optimization in Spark.                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                         |            |
| Module 4                                                                                                                                                                                                                                                      | NoSQL Databases and Data Storage                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Assessment: Assignment (NoSQL Database Operations and Data Modeling)    | 6 Sessions |

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| Introduction to NoSQL databases – Types of NoSQL (Key-Value, Document, Column, Graph) – MongoDB and Cassandra basics – Data modeling in NoSQL – Comparison with relational databases – Use cases in big data systems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                            |                                                                              |                   |
| <b>Module 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Big Data Analytics and Applications</b> | <b>Assessment:</b> Mini Project (Big Data Analytics Application Development) | <b>6 Sessions</b> |
| Real-time data processing – Streaming analytics (Spark Streaming basics) – Big data analytics in AI applications – Case studies in healthcare, finance, and smart cities – Ethical and privacy issues in big data – Future trends in big data analytics.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                            |                                                                              |                   |
| <p><b>List of Laboratory Tasks:</b></p> <p><b>Lab 1: Introduction to Big Data</b></p> <p>Understand the concept of big data and its characteristics (Volume, Velocity, Variety, Veracity, Value). Differentiate between traditional data processing and big data systems. Identify real-world applications such as social media analytics, healthcare, and e-commerce.</p> <p><b>Lab 2: Setup of Hadoop</b></p> <p>Install and configure Apache Hadoop. Understand Hadoop architecture including NameNode, DataNode, and YARN. Verify Hadoop installation and explore the Hadoop Distributed File System (HDFS).</p> <p><b>Lab 3: HDFS File Operations</b></p> <p>Perform file operations in HDFS such as creating directories, uploading files, downloading files, and deleting files. Analyze data storage and replication mechanisms in HDFS.</p> <p><b>Lab 4: MapReduce Word Count Program</b></p> <p>Develop a MapReduce program to perform word count on a dataset. Understand the working of mapper and reducer. Execute the program and analyze the output.</p> <p><b>Lab 5: MapReduce Data Processing</b></p> <p>Implement MapReduce programs for data processing tasks such as sorting, filtering, and aggregation. Analyze performance of distributed processing on large datasets.</p> <p><b>Lab 6: Introduction to Apache Spark</b></p> <p>Set up Apache Spark and understand its architecture. Compare Spark with Hadoop MapReduce. Study in-memory processing and its advantages..</p> <p><b>Lab 7: Spark RDD Operations</b></p> <p>Create Resilient Distributed Datasets (RDDs) and perform operations such as map, filter, and reduce. Analyze distributed data processing using Spark.</p> <p><b>Lab 8: Spark DataFrames and SQL</b></p> <p>Work with Spark DataFrames and perform SQL queries on structured data. Load datasets and perform data analysis using Spark SQL.</p> |                                            |                                                                              |                   |

**Lab 9: Big Data Processing using Spark**

Implement a Spark application to process large datasets. Perform transformations and actions. Analyze performance improvements over MapReduce.

**Lab 10: Introduction to NoSQL Databases**

Study NoSQL databases and their types (Key-Value, Document, Column, Graph). Understand differences between NoSQL and relational databases. Explore use cases in big data systems.

**Lab 11: MongoDB Implementation**

Install and configure MongoDB. Perform CRUD operations such as insert, update, delete, and query. Analyze document-based data storage.

**Lab 12: Cassandra Implementation**

Work with Cassandra database. Create keyspaces and tables. Insert and retrieve data. Understand distributed database architecture

**Lab 13: Big Data Analytics Application**

Perform data analytics using Spark on a real dataset. Apply transformations and generate insights. Analyze data trends and patterns.

**Lab 14: Introduction to Spark Streaming**

Understand the basics of streaming analytics using Spark. Process real-time data streams. Compare batch processing with streaming processing.

**Lab 15: Mini Project – Big Data Analytics System**

Develop an end-to-end big data analytics system using Hadoop, Spark, and NoSQL databases. Perform data ingestion, processing, and analysis. Present insights using real-world datasets.

**Targeted Applications & Tools:**

|                                             |                                         |
|---------------------------------------------|-----------------------------------------|
| <b>Hadoop (HDFS, MapReduce)</b>             | Distributed data storage and processing |
| <b>Apache Spark</b>                         | Fast data processing and analytics      |
| <b>NoSQL Databases (MongoDB, Cassandra)</b> | Big data storage                        |
| <b>Python / PySpark</b>                     | Data processing and analytics           |

**Skill-Building Activities through Experiential Learning:**

|                                                         |                |                |
|---------------------------------------------------------|----------------|----------------|
| •                                                       | Hadoop         | Implementation |
| Students perform data storage and processing using HDFS |                |                |
| •                                                       | Spark          | Programming    |
| Learners process large datasets using Spark             |                |                |
| •                                                       | NoSQL Database | Design         |
| Students design and query NoSQL databases               |                |                |
| •                                                       | Big Data Case  | Study          |

|                                                                                                                                                                                                 |
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| Learners analyze real-world big data applications                                                                                                                                               |
| <b>Textbooks</b><br><br>T1: Tom White, <i>“Hadoop: The Definitive Guide”</i> , O'Reilly Media<br><br>T2: Bill Chambers and Matei Zaharia, <i>“Spark: The Definitive Guide”</i> , O'Reilly Media |

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| <b>CourseCode:</b> ADS3406  | <b>CourseTitle:</b> Data Warehousing and Data Mining<br><b>Type ofCourse:</b> TheoryCourse                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>L-T-P-C</b> | 2-0-2-3 |
| <b>VersionNo.</b>           | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                |         |
| <b>NCrFLevel-</b>           | 5.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                |         |
| <b>Coursepre-requisites</b> | Database Management Systems, Statistical Foundations of Data Science, Introduction to Data Science                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                |         |
| <b>Co-requisites</b>        | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                |         |
| <b>Anti-requisites</b>      | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                |         |
| <b>CourseDescription</b>    | This course introduces the concepts of data warehousing and data mining for large-scale data analysis. It covers data warehouse design, OLAP operations, data preprocessing, and mining techniques such as classification, clustering, and association rule mining. Students will learn to extract meaningful patterns and knowledge from data for intelligent decision-making.                                                                                                                                                                                                               |                |         |
| <b>CourseObjective</b>      | To enable learners to design data warehouses and apply data mining techniques to discover patterns and insights from large datasets.                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                |         |
| <b>CourseOutcomes</b>       | On successful completion of the course the students shall be able to:<br><br><b>C01:</b> Understand data warehousing concepts and architectures.. [Level 2 – Understand]<br><b>C02:</b> Apply data preprocessing and OLAP techniques for data analysis. [Level 3 – Apply]<br><b>C03:</b> Apply data mining algorithms for classification, clustering, and association. [Level 3 – Apply]<br><b>C04:</b> Analyze patterns and knowledge extracted from datasets.. [Level 4 – Analyze]<br><b>C05:</b> Analyze data mining models and applications in real-world scenarios.. [Level 4 – Analyze] |                |         |
| <b>CourseContent:</b>       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                |         |

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| <b>Module 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Introduction to Data Warehousing</b>          | <b>Assessment: Quiz + Assignment (Data Warehouse Architecture and OLTP vs OLAP Analysis)</b>         | <b>6 Sessions</b> |
| Introduction to data warehousing – Characteristics and components of data warehouse – OLTP vs OLAP systems – Data warehouse architecture – Data marts and metadata – Applications of data warehousing in business and AI systems.                                                                                                                                                                                                                                                                                  |                                                  |                                                                                                      |                   |
| <b>Module 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Data Warehouse Design and OLAP</b>            | <b>Assessment: Assignment (Schema Design and OLAP Operations using SQL Tools)</b>                    | <b>6 Sessions</b> |
| Data warehouse design principles – Schema design (Star, Snowflake, Fact Constellation) – ETL (Extract, Transform, Load) process – OLAP operations (Roll-up, Drill-down, Slice, Dice) – Data cube and multidimensional analysis – Performance considerations.                                                                                                                                                                                                                                                       |                                                  |                                                                                                      |                   |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Data Preprocessing and Data Mining Basics</b> | <b>Assessment: Programming Assignment (Data Preprocessing using Python/Pandas)</b>                   | <b>6 Sessions</b> |
| Data preprocessing techniques – Data cleaning, integration, transformation, and reduction – Data discretization and normalization – Introduction to data mining – Types of data mining tasks – Evaluation of data quality.                                                                                                                                                                                                                                                                                         |                                                  |                                                                                                      |                   |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Data Mining Techniques</b>                    | <b>Assessment: Assignment (Classification, Clustering, and Association Rule Mining using Python)</b> | <b>6 Sessions</b> |
| Classification techniques (Decision Trees, Naïve Bayes) – Clustering techniques (K-Means, Hierarchical) – Association rule mining (Apriori algorithm) – Pattern evaluation and interestingness measures – Introduction to predictive analytics.                                                                                                                                                                                                                                                                    |                                                  |                                                                                                      |                   |
| <b>Module 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Advanced Data Mining and Applications</b>     | <b>Assessment: Mini Project (Real-World Data Mining Case Study)</b>                                  | <b>6 Sessions</b> |
| Sequential pattern mining – Outlier detection – Text and web mining basics – Data mining applications in healthcare, finance, and retail – Ethical and privacy issues in data mining – Case studies and emerging trends.                                                                                                                                                                                                                                                                                           |                                                  |                                                                                                      |                   |
| <b>List of Laboratory Tasks:</b><br><br><b>Lab 1: Introduction to Data Warehousing</b><br><br>Understand the concept of data warehousing and its components. Study differences between OLTP and OLAP systems. Identify applications of data warehousing in business and analytics.<br><br><b>Lab 2: Data Warehouse Architecture</b><br><br>Study data warehouse architecture including data sources, ETL process, and storage. Understand data marts and metadata. Analyze the flow of data in a warehouse system. |                                                  |                                                                                                      |                   |

**Lab 3: Schema Design (Star and Snowflake)**

Design data warehouse schemas such as star schema and snowflake schema. Understand fact tables and dimension tables. Analyze schema design for efficient querying.

**Lab 4: ETL Process Implementation**

Perform ETL operations including data extraction, transformation, and loading. Process data from different sources. Analyze data integration techniques.

**Lab 5: OLAP Operations**

Perform OLAP operations such as roll-up, drill-down, slice, and dice. Analyze multidimensional data using data cubes. Understand data aggregation techniques.

**Lab 6: Data Preprocessing**

Perform data preprocessing tasks such as cleaning, integration, transformation, and reduction. Prepare data for mining. Analyze data quality issues.

**Lab 7: Data Normalization and Transformation**

Apply normalization techniques and data transformation methods. Convert data into suitable format for analysis. Analyze impact on data mining performance.

**Lab 8: Classification using Decision Trees**

Implement classification using decision tree algorithms. Train and test model on dataset. Analyze classification accuracy and performance.

**Lab 9: Classification using Naïve Bayes**

Implement Naïve Bayes classification. Perform training and prediction. Analyze probabilistic model behavior.

**Lab 10: Clustering using K-Means**

Implement clustering using K-Means algorithm. Group data into clusters. Analyze clustering results and patterns.

**Lab 11: Hierarchical Clustering**

Perform hierarchical clustering. Analyze dendrogram and cluster formation. Compare with K-Means clustering.

**Lab 12: Association Rule Mining**

Implement association rule mining using Apriori algorithm. Generate frequent itemsets. Analyze rules using support and confidence.

**Lab 13: Pattern Evaluation**

Evaluate discovered patterns using interestingness measures. Analyze usefulness of extracted knowledge. Study pattern validation techniques.

**Lab 14: Outlier Detection**

Identify outliers in dataset using statistical or algorithmic methods. Analyze anomalies and unusual patterns in data.

**Lab 15: Mini Project – Data Mining Application**

Develop a complete data mining application. Perform preprocessing, apply mining techniques, and extract insights. Use real-world datasets and present results.

**Targeted Applications & Tools:**

|                                     |                                      |
|-------------------------------------|--------------------------------------|
| <b>SQL / Data Warehousing Tools</b> | Data extraction and warehouse design |
| <b>Python (NumPy, pandas)</b>       | Data preprocessing and analysis      |
| <b>Scikit-learn</b>                 | Classification and clustering        |
| <b>WEKA / RapidMiner</b>            | Data mining tools                    |

**Skill-Building Activities through Experiential Learning:**

|                                                             |                            |
|-------------------------------------------------------------|----------------------------|
| •                                                           | Data Warehouse Design      |
| Students design schema (Star/Snowflake) for datasets        |                            |
| •                                                           | Data Preprocessing         |
| Learners clean and transform datasets                       |                            |
| •                                                           | Data Mining Implementation |
| Students implement classification and clustering algorithms |                            |
| •                                                           | Pattern Discovery          |
| Learners extract association rules and insights             |                            |

**Textbooks**

T1: Jiawei Han, Micheline Kamber, and Jian Pei, *"Data Mining: Concepts and Techniques"*, Morgan Kaufmann

T2: Paulraj Ponniah, *"Data Warehousing Fundamentals"*, Wiley

**References**

1. Pang-Ning Tan, Michael Steinbach, *"Introduction to Data Mining"*, Pearson
2. Sam Anahory & Dennis Murray, *"Data Warehousing in the Real World"*, Pearson
3. K.P. Soman, *"Data Mining and Data Warehousing"*, PHI
4. Christopher Bishop, *"Pattern Recognition and Machine Learning"*, Springer
5. Kevin Murphy, *"Machine Learning: A Probabilistic Perspective"*, MIT Press

|                                 |   |      |             |                                                                 |
|---------------------------------|---|------|-------------|-----------------------------------------------------------------|
| <b>E-Resources/WebResources</b> |   |      |             |                                                                 |
| 1. NPTEL                        | - | Data | Warehousing | & Mining                                                        |
|                                 |   |      |             | <a href="https://nptel.ac.in">https://nptel.ac.in</a>           |
| 2. Coursera                     | - | Data |             | Mining                                                          |
|                                 |   |      |             | <a href="https://www.coursera.org">https://www.coursera.org</a> |
| 3. Kaggle                       |   |      |             | Datasets                                                        |
|                                 |   |      |             | <a href="https://www.kaggle.com">https://www.kaggle.com</a>     |

|                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                             |                   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-------------------|
| <b>CourseCode:</b><br>ADS3407                                                                                                                                                                                                                                  | <b>CourseTitle:</b> Distributed Data Processing using Hadoop and Spark<br><b>Type ofCourse:</b> TheoryCourse                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>L-T-P-C</b>                                                              | 2-0-2-3           |
| <b>VersionNo.</b>                                                                                                                                                                                                                                              | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                             |                   |
| <b>NCrFLevel-</b>                                                                                                                                                                                                                                              | 5.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                             |                   |
| <b>Coursepre-requisites</b>                                                                                                                                                                                                                                    | Data Structures and Algorithms, Database Management Systems, Introduction to Data Science                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                             |                   |
| <b>Co-requisites</b>                                                                                                                                                                                                                                           | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                             |                   |
| <b>Anti-requisites</b>                                                                                                                                                                                                                                         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                             |                   |
| <b>CourseDescription</b>                                                                                                                                                                                                                                       | This course introduces distributed data processing techniques using Hadoop and Apache Spark. It covers distributed storage, parallel processing, MapReduce programming, and in-memory data processing using Spark. Students will learn to process large-scale datasets efficiently and build scalable data analytics solutions.                                                                                                                                                                                                                                                 |                                                                             |                   |
| <b>CourseObjective</b>                                                                                                                                                                                                                                         | To enable learners to design and implement distributed data processing solutions using Hadoop and Spark for large-scale data analytics.                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                             |                   |
| <b>CourseOutcomes</b>                                                                                                                                                                                                                                          | On successful completion of the course the students shall be able to:<br><br><b>C01:</b> Understand distributed computing concepts and[Level 2 – Understand] Hadoop ecosystems..<br><b>C02:</b> Apply MapReduce programming model for data[Level 3 – Apply] processing.<br><b>C03:</b> Apply Spark framework for fast and scalable data[Level 3 – Apply] processing.<br><b>C04:</b> Analyze performance and scalability of distributed[Level 4 – Analyze] systems..<br><b>C05:</b> Analyze distributed data processing applications for[Level 4 – Analyze] real-world problems. |                                                                             |                   |
| <b>CourseContent:</b>                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                             |                   |
| <b>Module 1</b>                                                                                                                                                                                                                                                | <b>Introduction to Distributed Computing and Big Data</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Assessment: Assignment (Distributed Computing and Big Data Concepts)</b> | <b>6 Sessions</b> |
| Introduction to distributed computing – Challenges in large-scale data processing – Big Data characteristics (5Vs) – Distributed system architecture – Overview of Hadoop ecosystem – Applications in AI and Data Science – Introduction to cluster computing. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                             |                   |

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| <b>Module 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Hadoop Distributed File System</b>          | <b>Assessment: Quiz + Assignment (HDFS Operations and Data Management)</b>    | <b>6 Sessions</b> |
| HDFS architecture – NameNode and DataNode – Data storage and replication – Fault tolerance and reliability – Data access and file operations – HDFS commands and data management – Performance considerations in HDFS.                                                                                                                                                                                                                                                                                                                                                                     |                                                |                                                                               |                   |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>MapReduce Programming Model</b>             | <b>Assessment: Programming Assignment (MapReduce Application Development)</b> | <b>6 Sessions</b> |
| MapReduce concepts – Map and Reduce functions – Data flow in MapReduce – Writing MapReduce programs – Combiner and partitioner – Handling large datasets using MapReduce – Limitations of MapReduce.                                                                                                                                                                                                                                                                                                                                                                                       |                                                |                                                                               |                   |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Apache Spark for Distributed Processing</b> | <b>Assessment: Assignment (Spark Processing using PySpark)</b>                | <b>6 Sessions</b> |
| Introduction to Apache Spark – Spark architecture – Resilient Distributed Datasets (RDDs) – Transformations and actions – DataFrames and Spark SQL – In-memory processing advantages – Performance optimization techniques.                                                                                                                                                                                                                                                                                                                                                                |                                                |                                                                               |                   |
| <b>Module 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Advanced Spark and Applications</b>         | <b>Assessment: Mini Project (Real-Time Big Data Analytics using Spark)</b>    | <b>6 Sessions</b> |
| Spark Streaming basics – Machine learning with Spark (MLlib overview) – Graph processing (GraphX basics) – Real-time data processing – Case studies in big data analytics – Comparison of Hadoop vs Spark – Emerging trends.                                                                                                                                                                                                                                                                                                                                                               |                                                |                                                                               |                   |
| <b>List of Laboratory Tasks:</b><br><br><b>Lab 1: Introduction to Hadoop Environment</b><br><br>Understand the basics of Hadoop ecosystem and distributed computing. Explore Hadoop setup and basic commands.<br><br><b>Lab 2: HDFS File Operations</b><br><br>Perform basic HDFS operations such as creating directories, uploading files, viewing content, and deleting files.<br><br><b>Lab 3: Data Storage in HDFS</b><br><br>Store structured and unstructured datasets in HDFS and understand data replication and storage mechanism.<br><br><b>Lab 4: Introduction to MapReduce</b> |                                                |                                                                               |                   |

Understand MapReduce programming model and execute a basic example such as word count.

#### **Lab 5: Word Count using MapReduce**

Implement a word count program using MapReduce and analyze output.

#### **Lab 6: Simple Data Processing using MapReduce**

Perform basic data processing tasks such as filtering and counting using MapReduce.

#### **Lab 7: Introduction to Apache Spark**

Understand Spark architecture and set up Spark environment. Run basic Spark commands.

#### **Lab 8: Spark RDD Operations**

Perform operations such as map, filter, and reduce using RDDs in Spark.

#### **Lab 9: Spark DataFrames**

Load datasets into DataFrames and perform basic operations such as selection, filtering, and aggregation.

#### **Lab 10: Spark SQL Queries**

Execute SQL queries on datasets using Spark SQL and analyze results.

#### **Lab 11: Data Processing using PySpark**

Process datasets using PySpark and perform transformations and actions.

#### **Lab 12: Comparison of MapReduce and Spark**

Analyze performance and execution differences between MapReduce and Spark using sample datasets.

#### **Lab 13: Basic Spark Streaming**

Understand streaming concepts and implement a simple streaming example using Spark.

#### **Lab 14: Data Visualization of Results**

Visualize processed data using basic Python libraries such as Matplotlib.

#### **Lab 15: Mini Project – Distributed Data Processing**

Develop a simple distributed data processing application using Hadoop and Spark to analyze dataset.

#### **Targeted Applications & Tools:**

|                                 |                                          |
|---------------------------------|------------------------------------------|
| <b>Hadoop (HDFS, MapReduce)</b> | Distributed storage and batch processing |
| <b>Apache Spark (PySpark)</b>   | Fast data processing and analytics       |
| <b>Linux Environment</b>        | Cluster setup and execution              |
| Python (PySpark)                | Distributed data analysis                |

#### **Skill-Building Activities through Experiential Learning:**

|                                                                                                                                                                                                                                                                                                                                                                                                   |           |                 |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------------|
| •                                                                                                                                                                                                                                                                                                                                                                                                 | HDFS      | Operations      |
| Students perform file storage and management in Hadoop                                                                                                                                                                                                                                                                                                                                            |           |                 |
| •                                                                                                                                                                                                                                                                                                                                                                                                 | MapReduce | Programming     |
| Learners implement basic MapReduce programs                                                                                                                                                                                                                                                                                                                                                       |           |                 |
| •                                                                                                                                                                                                                                                                                                                                                                                                 | Spark     | Data Processing |
| Students process datasets using PySpark                                                                                                                                                                                                                                                                                                                                                           |           |                 |
| •                                                                                                                                                                                                                                                                                                                                                                                                 | Real-Time | Data Analysis   |
| Learners explore streaming data processing                                                                                                                                                                                                                                                                                                                                                        |           |                 |
| <b>Textbooks</b>                                                                                                                                                                                                                                                                                                                                                                                  |           |                 |
| T1: Tom White, <i>"Hadoop: The Definitive Guide"</i> , O'Reilly Media                                                                                                                                                                                                                                                                                                                             |           |                 |
| T2: Bill Chambers and Matei Zaharia, <i>"Spark: The Definitive Guide"</i> , O'Reilly Media                                                                                                                                                                                                                                                                                                        |           |                 |
| <b>References</b>                                                                                                                                                                                                                                                                                                                                                                                 |           |                 |
| <ul style="list-style-type: none"> <li>• Holden Karau et al., <i>"Learning Spark"</i>, O'Reilly</li> <li>• Neha Narkhede et al., <i>"Kafka: The Definitive Guide"</i>, O'Reilly</li> <li>• Seema Acharya, <i>"Big Data Analytics"</i>, Wiley</li> <li>• Jiawei Han, <i>"Data Mining: Concepts and Techniques"</i></li> <li>• Viktor Mayer-Schönberger, <i>"Big Data: A Revolution"</i></li> </ul> |           |                 |
| <b>E-Resources/WebResources</b>                                                                                                                                                                                                                                                                                                                                                                   |           |                 |
| 4. Apache                                                                                                                                                                                                                                                                                                                                                                                         |           | Hadoop          |
| <a href="https://hadoop.apache.org">https://hadoop.apache.org</a>                                                                                                                                                                                                                                                                                                                                 |           |                 |
| 5. Apache                                                                                                                                                                                                                                                                                                                                                                                         |           | Spark           |
| <a href="https://spark.apache.org">https://spark.apache.org</a>                                                                                                                                                                                                                                                                                                                                   |           |                 |
| 6. NPTEL                                                                                                                                                                                                                                                                                                                                                                                          | –         | Big Data        |
| <a href="https://nptel.ac.in">https://nptel.ac.in</a>                                                                                                                                                                                                                                                                                                                                             |           |                 |

|                              |                                                                                                |                |         |
|------------------------------|------------------------------------------------------------------------------------------------|----------------|---------|
| <b>Course Code:</b> ADS3408  | <b>Course Title:</b> Data Engineering and ETL Pipelines<br><b>Type of Course:</b> TheoryCourse | <b>L-T-P-C</b> | 2-0-2-3 |
| <b>Version No.</b>           | 1.0                                                                                            |                |         |
| <b>NCrF Level-</b>           | 5.0                                                                                            |                |         |
| <b>Course pre-requisites</b> | Database Management Systems, Introduction to Data Science, Python Programming                  |                |         |
| <b>Co-requisites</b>         | -                                                                                              |                |         |
| <b>Anti-requisites</b>       | NIL                                                                                            |                |         |

|                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                        |            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|------------|
| CourseDescription                                                                                                                                                                                                                              | This course focuses on data engineering concepts and ETL (Extract, Transform, Load) pipelines for building scalable data systems. It covers data ingestion, transformation, storage, and pipeline orchestration using modern tools and frameworks. Students will learn to design and implement end-to-end data pipelines for real-world data analytics and AI applications.                                                                                                                                         |                                                                                        |            |
| CourseObjective                                                                                                                                                                                                                                | To enable learners to design, build, and manage ETL pipelines and data engineering workflows for processing large-scale structured and unstructured data.                                                                                                                                                                                                                                                                                                                                                           |                                                                                        |            |
| CourseOutcomes                                                                                                                                                                                                                                 | On successful completion of the course the students shall be able to:<br><br>CO1: Understand data engineering concepts and ETL[Level 2 – Understand] pipeline architecture.<br>CO2: Apply data extraction, transformation, and loading[Level 3 – Apply] techniques.<br>CO3: Analyze data workflows and pipeline performance. [Level 4 – Analyze]<br>CO4: Analyze data quality and pipeline reliability. [Level 4 – Analyze]<br>CO5: Analyze scalable data pipelines for real-world[Level 4 – Analyze] applications. |                                                                                        |            |
| CourseContent:                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                        |            |
| Module 1                                                                                                                                                                                                                                       | Introduction to Data Engineering and Pipelines                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Assessment: Quiz + Assignment (Data Pipeline Architecture and ETL Concepts)            | 6 Sessions |
| Introduction to data engineering – Role of data engineers in AI/DS systems – Data pipeline architecture – Batch vs real-time processing – Data sources: databases, APIs, logs – Overview of ETL processes – Data flow and pipeline lifecycle.  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                        |            |
| Module 2                                                                                                                                                                                                                                       | Data Ingestion and Extraction                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Assessment: Programming Assignment (Data Ingestion using Python and APIs)              | 6 Sessions |
| Data extraction from relational databases – Data ingestion from APIs and streaming sources – Data formats (CSV, JSON, Parquet) – Data integration techniques – Handling structured and unstructured data – Data ingestion tools and workflows. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                        |            |
| Module 3                                                                                                                                                                                                                                       | Data Transformation and Processing                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Assessment: Assignment (Data Transformation and Feature Engineering using pandas)      | 6 Sessions |
| Data cleaning and preprocessing – Data transformation techniques – Feature engineering basics – Data validation and quality checks – Transformation using Python (pandas) – Introduction to distributed processing for ETL.                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                        |            |
| Module 4                                                                                                                                                                                                                                       | Data Storage and Pipeline Orchestration                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Assessment: Assignment (Data Storage and Workflow Scheduling using SQL/Airflow Basics) | 6 Sessions |

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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|----------------------------------------------------------------------------------------|-------------------|
| Data storage systems: Data lakes and data warehouses – SQL and NoSQL storage – ETL vs ELT approaches – Pipeline orchestration concepts – Workflow scheduling (Airflow basics) – Monitoring and logging of pipelines.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                   |                                                                                        |                   |
| <b>Module 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Scalable Data Engineering and Applications</b> | <b>Assessment: Mini Project (Scalable Data Pipeline Case Study using Hadoop/Spark)</b> | <b>6 Sessions</b> |
| Big data pipelines using Hadoop and Spark – Real-time data pipelines – Cloud-based data engineering (AWS/GCP basics) – Data pipeline optimization – Case studies in data engineering – Ethical and privacy issues in data pipelines.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                   |                                                                                        |                   |
| <p><b>List of Laboratory Tasks:</b></p> <p><b>Lab 1: Introduction to Data Engineering</b></p> <p>Understand the concept of data engineering and its role in data analytics and AI systems. Study data pipeline architecture and differentiate between batch processing and real-time processing. Identify real-world data sources such as databases, APIs, and logs.</p> <p><b>Lab 2: Data Extraction from Databases</b></p> <p>Extract data from relational databases using SQL queries. Perform data retrieval operations and analyze structured data. Understand database connectivity and data extraction techniques.</p> <p><b>Lab 3: Data Ingestion from APIs</b></p> <p>Implement data ingestion from APIs. Fetch real-time or batch data in formats such as JSON. Analyze API-based data integration and ingestion workflows.</p> <p><b>Lab 4: Data Ingestion from Files</b></p> <p>Load datasets from files such as CSV, JSON, and Parquet. Perform file-based data ingestion. Analyze structured and semi-structured data formats.</p> <p><b>Lab 5: Data Cleaning and Preprocessing</b></p> <p>Perform data cleaning operations such as handling missing values, duplicates, and inconsistencies. Apply preprocessing techniques using Python libraries like pandas.</p> <p><b>Lab 6: Data Transformation using Python</b></p> <p>Apply data transformation techniques such as filtering, aggregation, and feature engineering. Use pandas for data manipulation and analysis.</p> <p><b>Lab 7: Data Validation and Quality Checks</b></p> |                                                   |                                                                                        |                   |

Implement data validation techniques to ensure data quality. Perform checks for accuracy, completeness, and consistency. Analyze data reliability.

#### **Lab 8: ETL Pipeline Implementation**

Design and implement a basic ETL pipeline. Extract data from source, transform it, and load it into a target system. Analyze data flow and pipeline execution.

#### **Lab 9: Data Storage in Data Lakes/Warehouses**

Store processed data in data lakes or data warehouses. Understand storage systems and data organization. Compare different storage approaches.

#### **Lab 10: SQL and NoSQL Integration**

Work with both SQL and NoSQL databases. Store and retrieve data. Analyze differences between structured and unstructured data storage.

#### **Lab 11: Workflow Orchestration using Airflow**

Implement workflow scheduling using Apache Airflow. Create DAGs (Directed Acyclic Graphs) for ETL pipelines. Analyze pipeline automation and scheduling.

#### **Lab 12: Monitoring and Logging of Pipelines**

Monitor ETL pipeline execution. Analyze logs and performance metrics. Identify issues and optimize workflows.

#### **Lab 13: Big Data ETL using Spark**

Implement ETL pipeline using Apache Spark. Process large datasets and perform distributed data transformation.

#### **Lab 14: Real-Time Data Pipeline**

Design a real-time data pipeline using streaming or API data sources. Process data continuously and analyze system performance.

#### **Lab 15: Mini Project – End-to-End Data Engineering Pipeline**

Develop a complete data engineering pipeline. Perform data extraction, transformation, storage, and analysis. Use real-world datasets and present insights.

#### **Targeted Applications & Tools:**

|                               |                                    |
|-------------------------------|------------------------------------|
| <b>Python (pandas, NumPy)</b> | Data transformation and processing |
| <b>SQL</b>                    | Data extraction and querying       |

|                                                                                                                                                                                                                                                                                                                                                                                    |                             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| <b>Apache Airflow (Basics)</b>                                                                                                                                                                                                                                                                                                                                                     | Workflow orchestration      |
| <b>Hadoop / Spark</b>                                                                                                                                                                                                                                                                                                                                                              | Distributed data processing |
| <b>Cloud Platforms (AWS/GCP – Basics)</b>                                                                                                                                                                                                                                                                                                                                          | Data pipeline deployment    |
| <b>Skill-Building Activities through Experiential Learning:</b>                                                                                                                                                                                                                                                                                                                    |                             |
| <ul style="list-style-type: none"> <li>ETL Pipeline Development<br/>Students build ETL pipelines using Python</li> <li>Data Ingestion Projects<br/>Learners extract data from APIs and databases</li> <li>Data Transformation Tasks<br/>Students clean and transform datasets</li> <li>Pipeline Monitoring<br/>Learners analyze performance and optimize workflows</li> </ul>      |                             |
| <b>Textbooks</b>                                                                                                                                                                                                                                                                                                                                                                   |                             |
| T1: Joe Reis and Matt Housley, <i>“Fundamentals of Data Engineering”</i> , O’Reilly Media                                                                                                                                                                                                                                                                                          |                             |
| T2: Ralph Kimball, <i>“The Data Warehouse Toolkit”</i> , Wiley                                                                                                                                                                                                                                                                                                                     |                             |
| <b>References</b>                                                                                                                                                                                                                                                                                                                                                                  |                             |
| <ul style="list-style-type: none"> <li>Bill Chambers, <i>“Spark: The Definitive Guide”</i></li> <li>Martin Kleppmann, <i>“Designing Data-Intensive Applications”</i>, O’Reilly</li> <li>Tyler Akidau, <i>“Streaming Systems”</i>, O’Reilly</li> <li>Jiawei Han, <i>“Data Mining: Concepts and Techniques”</i></li> <li>Tom White, <i>“Hadoop: The Definitive Guide”</i></li> </ul> |                             |
| <b>E-Resources/WebResources</b>                                                                                                                                                                                                                                                                                                                                                    |                             |
| 7. Apache                                                                                                                                                                                                                                                                                                                                                                          | Airflow                     |
| <a href="https://airflow.apache.org">https://airflow.apache.org</a>                                                                                                                                                                                                                                                                                                                |                             |
| 8. AWS                                                                                                                                                                                                                                                                                                                                                                             | Data Engineering            |
| <a href="https://aws.amazon.com">https://aws.amazon.com</a>                                                                                                                                                                                                                                                                                                                        |                             |
| 9. Google                                                                                                                                                                                                                                                                                                                                                                          | Cloud Data Engineering      |
| <a href="https://cloud.google.com">https://cloud.google.com</a>                                                                                                                                                                                                                                                                                                                    |                             |

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| <b>CourseCode:</b><br>ADS3409 | <b>CourseTitle:</b> Cloud-Based Data Analytics<br><b>Type</b> of Course: Theory Course | <b>L-T-P-C</b> | 2-0-2-3 |
| <b>VersionNo.</b>             | 1.0                                                                                    |                |         |
| <b>NCrFLevel-</b>             | 5.0                                                                                    |                |         |
| <b>Coursepre-requisites</b>   | Database Management Systems, Introduction to Data Science, Big Data Analytics          |                |         |

|                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                              |            |
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| Co-requisites                                                                                                                                                                                                                                                                   | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                              |            |
| Anti-requisites                                                                                                                                                                                                                                                                 | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                              |            |
| CourseDescription                                                                                                                                                                                                                                                               | This course introduces cloud computing concepts for data analytics, focusing on scalable storage, distributed processing, and cloud-based machine learning services. It covers cloud platforms such as AWS, Azure, and Google Cloud, along with tools for data ingestion, processing, and visualization. Students will learn to build and deploy data analytics solutions in cloud environments.                                                                                                                                            |                                                                                              |            |
| CourseObjective                                                                                                                                                                                                                                                                 | To enable learners to design and implement scalable data analytics solutions using cloud platforms and services.                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                              |            |
| CourseOutcomes                                                                                                                                                                                                                                                                  | On successful completion of the course the students shall be able to:<br><br>C01: Understand cloud computing concepts and architecture[Level 2 – Understand] for data analytics..<br>C02: Apply cloud services for data storage and processing. [Level 3 – Apply]<br>C03: Analyze datasets using cloud-based analytics tools. [Level 4 – Analyze]<br>C04: Analyze performance and scalability of cloud solutions. [Level 4 – Analyze]<br>C05: Analyze cloud-based data analytics applications for real-[Level 4 – Analyze] world scenarios. |                                                                                              |            |
| CourseContent:                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                              |            |
| Module 1                                                                                                                                                                                                                                                                        | Introduction to Cloud Computing and Data Analytics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Assessment: Quiz + Assignment (Cloud Service Models and Cloud Platforms Analysis)            | 6 Sessions |
| Introduction to cloud computing – Cloud service models (IaaS, PaaS, SaaS) – Deployment models (Public, Private, Hybrid) – Role of cloud in data analytics – Advantages and challenges – Overview of cloud platforms (AWS, Azure, GCP) – Cloud architecture basics.              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                              |            |
| Module 2                                                                                                                                                                                                                                                                        | Cloud Storage and Data Management                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Assessment: Assignment (Cloud Storage and Database Services using AWS/Azure/GCP Basics)      | 6 Sessions |
| Cloud storage services (Amazon S3, Azure Blob Storage, Google Cloud Storage) – Data ingestion in cloud – Structured and unstructured data handling – Data lakes and data warehouses in cloud – Database services (RDS, BigQuery, Azure SQL) – Data security and access control. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                              |            |
| Module 3                                                                                                                                                                                                                                                                        | Cloud-Based Data Processing and Analytics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Assessment: Programming Assignment (Distributed Data Processing using Spark and Cloud Tools) | 6 Sessions |
| Distributed processing in cloud – Cloud-based big data tools (AWS EMR, Dataproc) – Data processing using Spark in cloud – Serverless data processing (AWS Lambda basics) – Querying data using cloud tools – Workflow for cloud analytics.                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                              |            |
| Module 4                                                                                                                                                                                                                                                                        | Machine Learning and Visualization in Cloud                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Assessment: Assignment (Cloud ML and Dashboard Development using Cloud                       | 6 Sessions |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                         | Visualization Tools)                                                             |            |
| Cloud ML services (AWS SageMaker, Azure ML, Google AI Platform) – Model training and deployment – Visualization tools in cloud (QuickSight, Power BI, Looker) – Dashboard creation – Monitoring and evaluation of models.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                         |                                                                                  |            |
| Module 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Cloud Data Engineering and Applications | Assessment: Mini Project (Cloud-Based Data Engineering and Analytics Case Study) | 6 Sessions |
| ETL pipelines in cloud – Data pipeline orchestration – Real-time data processing in cloud – Case studies (e-commerce, healthcare, finance) – Cost optimization in cloud analytics – Ethical and privacy issues in cloud systems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                         |                                                                                  |            |
| <p><b>List of Laboratory Tasks:</b></p> <p><b>Lab 1: Introduction to Cloud Computing</b></p> <p>Understand the concept of cloud computing and its service models (IaaS, PaaS, SaaS). Study deployment models such as public, private, and hybrid cloud. Identify real-world applications of cloud in data analytics.</p> <p><b>Lab 2: Setup of Cloud Platform</b></p> <p>Create an account in cloud platforms such as AWS, Azure, or Google Cloud. Explore cloud dashboard and services. Understand basic cloud architecture and resource management.</p> <p><b>Lab 3: Cloud Storage Implementation</b></p> <p>Work with cloud storage services such as Amazon S3, Azure Blob Storage, or Google Cloud Storage. Create buckets, upload datasets, and manage storage. Analyze scalability and accessibility of cloud storage.</p> <p><b>Lab 4: Data Ingestion in Cloud</b></p> <p>Perform data ingestion into cloud storage. Upload structured and unstructured datasets. Study data ingestion techniques and observe data flow in cloud environment.</p> <p><b>Lab 5: Cloud Database Services</b></p> <p>Use cloud-based database services such as Amazon RDS, BigQuery, or Azure SQL. Create databases, insert records, and query data. Understand managed database services in cloud.</p> <p><b>Lab 6: Cloud-Based Data Processing</b></p> <p>Perform data processing using cloud tools such as AWS EMR or Google Dataproc. Execute data processing tasks and analyze distributed computing in cloud.</p> <p><b>Lab 7: Spark Processing in Cloud</b></p> <p>Set up Apache Spark in cloud environment. Process datasets using PySpark. Perform basic transformations and actions on cloud data.</p> |                                         |                                                                                  |            |

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| <b>Lab 8: Serverless Data Processing</b>                                                                                                                         |                                    |              |
| Implement serverless computing using AWS Lambda or similar services. Execute functions without managing servers. Analyze event-driven processing in cloud.       |                                    |              |
| <b>Lab 9: Querying Cloud Data</b>                                                                                                                                |                                    |              |
| Query datasets using cloud analytics tools such as BigQuery or Athena. Perform SQL-based data analysis. Observe performance and scalability.                     |                                    |              |
| <b>Lab 10: Cloud ETL Pipeline</b>                                                                                                                                |                                    |              |
| Design and implement ETL pipeline in cloud. Extract data from source, transform it, and load into storage or database. Analyze workflow of cloud data pipelines. |                                    |              |
| <b>Lab 11: Data Visualization in Cloud</b>                                                                                                                       |                                    |              |
| Create dashboards using Power BI, Tableau, or cloud-native tools like QuickSight. Visualize datasets and analyze trends dynamically.                             |                                    |              |
| <b>Lab 12: Machine Learning in Cloud</b>                                                                                                                         |                                    |              |
| Use cloud ML services such as AWS SageMaker or Azure ML. Train and deploy models. Analyze predictions using cloud-based machine learning.                        |                                    |              |
| <b>Lab 13: Real-Time Data Processing in Cloud</b>                                                                                                                |                                    |              |
| Implement real-time data processing using cloud streaming services. Analyze streaming data and observe system performance.                                       |                                    |              |
| <b>Lab 14: Cloud Security and Cost Optimization</b>                                                                                                              |                                    |              |
| Implement security measures such as IAM roles and access control. Monitor cloud usage and optimize cost. Analyze performance and resource utilization.           |                                    |              |
| <b>Lab 15: Mini Project – End-to-End Cloud Analytics System</b>                                                                                                  |                                    |              |
| Develop a complete cloud-based data analytics system. Perform data storage, processing, and visualization. Analyze real-world dataset and present insights.      |                                    |              |
| <b>Targeted Applications &amp; Tools:</b>                                                                                                                        |                                    |              |
| <b>AWS / Azure / Google Cloud</b>                                                                                                                                | Cloud platforms for data analytics |              |
| <b>Amazon S3 / BigQuery / Azure Storage</b>                                                                                                                      | Cloud storage                      |              |
| <b>Apache Spark (Cloud-based)</b>                                                                                                                                | Distributed data processing        |              |
| <b>Python (pandas, PySpark)</b>                                                                                                                                  | Data analysis and transformation   |              |
| <b>Power BI / Tableau / QuickSight</b>                                                                                                                           | Visualization and dashboards       |              |
| <b>Skill-Building Activities through Experiential Learning:</b>                                                                                                  |                                    |              |
| •                                                                                                                                                                | Cloud                              | Data Storage |

|                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                       |       |             |
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| Students store and manage datasets in cloud                                                                                                                                                                                                                                                                                                                                                                   |                                                                       |       |             |
| •                                                                                                                                                                                                                                                                                                                                                                                                             | Cloud-Based                                                           | Data  | Processing  |
| Learners process data using Spark or cloud tools                                                                                                                                                                                                                                                                                                                                                              |                                                                       |       |             |
| •                                                                                                                                                                                                                                                                                                                                                                                                             | Dashboard                                                             |       | Development |
| Students create cloud-based dashboards                                                                                                                                                                                                                                                                                                                                                                        |                                                                       |       |             |
| •                                                                                                                                                                                                                                                                                                                                                                                                             | End-to-End                                                            | Cloud | Project     |
| Learners build complete data analytics pipeline                                                                                                                                                                                                                                                                                                                                                               |                                                                       |       |             |
| <b>Textbooks</b>                                                                                                                                                                                                                                                                                                                                                                                              |                                                                       |       |             |
| T1: Foster Provost & Tom Fawcett, <i>"Data Science for Business"</i> , O'Reilly                                                                                                                                                                                                                                                                                                                               |                                                                       |       |             |
| T2: Rajkumar Buyya, <i>"Mastering Cloud Computing"</i> , McGraw Hill                                                                                                                                                                                                                                                                                                                                          |                                                                       |       |             |
| <b>References</b>                                                                                                                                                                                                                                                                                                                                                                                             |                                                                       |       |             |
| <ul style="list-style-type: none"> <li>• Martin Kleppmann, <i>"Designing Data-Intensive Applications"</i></li> <li>• Tom White, <i>"Hadoop: The Definitive Guide"</i></li> <li>• Bill Chambers, <i>"Spark: The Definitive Guide"</i></li> <li>• Joe Reis, <i>"Fundamentals of Data Engineering"</i></li> <li>• Kai Hwang, <i>"Cloud Computing for Machine Learning and Cognitive Applications"</i></li> </ul> |                                                                       |       |             |
| <b>E-Resources/WebResources</b>                                                                                                                                                                                                                                                                                                                                                                               |                                                                       |       |             |
| •                                                                                                                                                                                                                                                                                                                                                                                                             | AWS                                                                   |       | Training    |
|                                                                                                                                                                                                                                                                                                                                                                                                               | <a href="https://aws.amazon.com">https://aws.amazon.com</a>           |       |             |
| •                                                                                                                                                                                                                                                                                                                                                                                                             | Microsoft                                                             | Azure | Learning    |
|                                                                                                                                                                                                                                                                                                                                                                                                               | <a href="https://learn.microsoft.com">https://learn.microsoft.com</a> |       |             |
| •                                                                                                                                                                                                                                                                                                                                                                                                             | Google                                                                | Cloud | Training    |
|                                                                                                                                                                                                                                                                                                                                                                                                               | <a href="https://cloud.google.com">https://cloud.google.com</a>       |       |             |

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| <b>CourseCode:</b><br>ADS3410 | <b>CourseTitle:</b> Real-Time Stream Data Analytics<br><b>Type ofCourse:</b> TheoryCourse                                                                                                                                                                                                                                                                                 | <b>L-T-P-C</b> | 2-<br>0-<br>2-<br>3 |
| <b>VersionNo.</b>             | 1.0                                                                                                                                                                                                                                                                                                                                                                       |                |                     |
| <b>NCrFLevel-</b>             | 5.0                                                                                                                                                                                                                                                                                                                                                                       |                |                     |
| <b>Coursepre-requisites</b>   | Big Data Analytics, Data Engineering and ETL Pipelines, Introduction to Data Science                                                                                                                                                                                                                                                                                      |                |                     |
| <b>Co-requisites</b>          | -                                                                                                                                                                                                                                                                                                                                                                         |                |                     |
| <b>Anti-requisites</b>        | NIL                                                                                                                                                                                                                                                                                                                                                                       |                |                     |
| <b>CourseDescription</b>      | This course introduces real-time data processing and stream analytics using modern distributed systems. It covers streaming architectures, event-driven systems, message queues, and real-time analytics frameworks such as Kafka and Spark Streaming. Students will learn to design and implement scalable real-time data pipelines for AI and data-driven applications. |                |                     |

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| CourseObjective                                                                                                                                                                                                                                 | To enable learners to design and implement real-time data processing systems and analyze streaming data using distributed frameworks.                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                  |            |
| CourseOutcomes                                                                                                                                                                                                                                  | On successful completion of the course the students shall be able to:<br><br>C01: Understand real-time data processing concepts and[Level 2 – Understand] streaming architectures.<br>C02: Apply stream processing frameworks for data ingestion[Level 3 – Apply] and processing.<br>C03: Analyze streaming data using real-time analytics[Level 4 – Analyze] techniques.<br>C04: Analyze performance and scalability of streaming[Level 4 – Analyze] systems.<br>C05: Analyze real-time data pipelines for AI and data-driven[Level 4 – Analyze] applications.. |                                                                                  |            |
| CourseContent:                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                  |            |
| Module 1                                                                                                                                                                                                                                        | Introduction to Real-Time Data and Streaming Systems                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Assessment: Quiz + Assignment (Real-Time Data Processing and Streaming Concepts) | 6 Sessions |
| Introduction to real-time data processing – Batch vs stream processing – Characteristics of streaming data – Event-driven architecture – Use cases of real-time analytics – Overview of streaming frameworks – Challenges in real-time systems. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                  |            |
| Module 2                                                                                                                                                                                                                                        | Data Ingestion and Messaging Systems                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Assessment: Assignment (Apache Kafka Architecture and Streaming Pipelines)       | 6 Sessions |
| Data ingestion in streaming systems – Message brokers and queues – Introduction to Apache Kafka – Kafka architecture (producers, consumers, topics) – Data streams and event pipelines – Data reliability and fault tolerance.                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                  |            |
| Module 3                                                                                                                                                                                                                                        | Stream Processing Frameworks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Assessment: Programming Assignment (Spark Streaming and Window Operations)       | 6 Sessions |
| Introduction to stream processing – Spark Streaming concepts – Micro-batch processing – Window operations – Stateful stream processing – Data transformation in streaming – Comparison of batch vs stream processing.                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                  |            |
| Module 4                                                                                                                                                                                                                                        | Real-Time Analytics and Applications                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Assessment: Assignment (Real-Time Analytics and Dashboard                        | 6 Sessions |

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| Real-time data analytics techniques – Processing streaming data with Spark – Real-time dashboards and visualization – Anomaly detection in streaming data – Use cases: fraud detection, IoT, social media analytics – Performance optimization.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                             |                                                                     |            |
| Module 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Advanced Streaming Systems and Case Studies | Assessment: Mini Project (Real-Time Streaming Analytics Case Study) | 6 Sessions |
| Advanced stream processing (Kafka Streams overview) – Integration with big data systems – Real-time ETL pipelines – Scaling streaming systems – Ethical and privacy issues – Case studies in real-time analytics – Future trends.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                             |                                                                     |            |
| <b>List of Laboratory Tasks:</b><br><br><b>Lab 1: Introduction to Streaming Data</b><br><br>Understand the concept of real-time data and differentiate between batch processing and stream processing. Study characteristics of streaming data and identify real-world applications such as IoT, stock markets, and social media analytics.<br><br><b>Lab 2: Setup of Apache Kafka</b><br><br>Install and configure Apache Kafka. Understand Kafka architecture including brokers, topics, producers, and consumers. Create and manage topics for real-time data streaming.<br><br><b>Lab 3: Kafka Producer Implementation</b><br><br>Develop a Kafka producer application to send real-time data (e.g., sensor or log data) to a Kafka topic. Analyze message flow and data streaming behavior.<br><br><b>Lab 4: Kafka Consumer Implementation</b><br><br>Develop a Kafka consumer application to read and process real-time data from Kafka topics. Understand offset management and message consumption.<br><br><b>Lab 5: Real-Time Data Ingestion Pipeline</b><br><br>Build an end-to-end data ingestion pipeline using Kafka to stream data from source to destination. Observe real-time data flow and system behavior.<br><br><b>Lab 6: Introduction to Spark Streaming</b><br><br>Set up Apache Spark and understand the fundamentals of Spark Streaming. Study micro-batch processing and its role in real-time analytics.<br><br><b>Lab 7: Spark Streaming Basic Program</b><br><br>Implement a basic Spark Streaming application to process streaming data. Perform simple operations such as counting and filtering data streams. |                                             |                                                                     |            |

**Lab 8: Window Operations in Streaming**

Implement window-based operations such as sliding window and tumbling window in Spark Streaming. Analyze how time-based processing works in real-time systems.

**Lab 9: Real-Time Data Transformation**

Apply transformations such as map, filter, and reduce on streaming data. Process real-time datasets and observe output behavior.

**Lab 10: Integration of Kafka with Spark Streaming**

Integrate Apache Kafka with Spark Streaming to build a real-time data processing pipeline. Consume Kafka data streams and process them using Spark.

**Lab 11: Real-Time Dashboard Creation**

Create dashboards using Power BI or Tableau to visualize streaming data. Display real-time updates and analyze trends dynamically.

**Lab 12: Anomaly Detection in Streaming Data**

Implement basic anomaly detection techniques on streaming data using statistical or machine learning methods. Identify unusual patterns in real-time.

**Lab 13: Real-Time ETL Pipeline**

Design and implement an ETL pipeline for streaming data. Extract data from Kafka, transform it using Spark, and load it into storage or visualization tools.

**Lab 14: Performance Optimization in Streaming Systems**

Analyze performance metrics such as latency and throughput in streaming systems. Optimize configurations for better performance.

**Lab 15: Mini Project – End-to-End Streaming System**

Develop a complete real-time analytics system using Kafka, Spark, and visualization tools. Implement data ingestion, processing, and visualization in an integrated pipeline.

**Targeted Applications & Tools:**

|                                         |                                        |
|-----------------------------------------|----------------------------------------|
| <b>Apache Kafka</b>                     | Real-time data ingestion and messaging |
| <b>Apache Spark Streaming / PySpark</b> | Cloud storage                          |
| <b>Python</b>                           | Data transformation and analytics      |
| <b>Power BI / Tableau</b>               | Real-time dashboards                   |

**Skill-Building Activities through Experiential Learning:**

|                                                                                                                                                                                                                                                                                                                                                                 |           |            |             |
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| •                                                                                                                                                                                                                                                                                                                                                               | Kafka     | Stream     | Setup       |
| Students implement producer-consumer model                                                                                                                                                                                                                                                                                                                      |           |            |             |
| •                                                                                                                                                                                                                                                                                                                                                               | Stream    | Processing | using Spark |
| Learners process streaming datasets                                                                                                                                                                                                                                                                                                                             |           |            |             |
| •                                                                                                                                                                                                                                                                                                                                                               |           | Real-Time  | Dashboard   |
| Students visualize live data streams                                                                                                                                                                                                                                                                                                                            |           |            |             |
| •                                                                                                                                                                                                                                                                                                                                                               | Streaming | Pipeline   | Project     |
| Learners build end-to-end real-time system                                                                                                                                                                                                                                                                                                                      |           |            |             |
| <b>Textbooks</b>                                                                                                                                                                                                                                                                                                                                                |           |            |             |
| T1: Tyler Akidau et al., “ <i>Streaming Systems</i> ”, O’Reilly Media                                                                                                                                                                                                                                                                                           |           |            |             |
| T2: Neha Narkhede et al., “ <i>Kafka: The Definitive Guide</i> ”, O’Reilly Media                                                                                                                                                                                                                                                                                |           |            |             |
| <b>References</b>                                                                                                                                                                                                                                                                                                                                               |           |            |             |
| <ul style="list-style-type: none"> <li>• Bill Chambers, “<i>Spark: The Definitive Guide</i>”</li> <li>• Martin Kleppmann, “<i>Designing Data-Intensive Applications</i>”</li> <li>• Holden Karau, “<i>Learning Spark</i>”</li> <li>• Tom White, “<i>Hadoop: The Definitive Guide</i>”</li> <li>• Joe Reis, “<i>Fundamentals of Data Engineering</i>”</li> </ul> |           |            |             |
| <b>E-Resources/WebResources</b>                                                                                                                                                                                                                                                                                                                                 |           |            |             |
| • AWS                                                                                                                                                                                                                                                                                                                                                           |           |            | Training    |
| <a href="https://aws.amazon.com">https://aws.amazon.com</a>                                                                                                                                                                                                                                                                                                     |           |            |             |
| • Microsoft                                                                                                                                                                                                                                                                                                                                                     | Azure     |            | Learning    |
| <a href="https://learn.microsoft.com">https://learn.microsoft.com</a>                                                                                                                                                                                                                                                                                           |           |            |             |
| • Google                                                                                                                                                                                                                                                                                                                                                        | Cloud     |            | Training    |
| <a href="https://cloud.google.com">https://cloud.google.com</a>                                                                                                                                                                                                                                                                                                 |           |            |             |

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| <b>Course Code:</b><br>ADS3411 | <b>Course Name:</b> Business Intelligence and Analytics<br><b>Type of Course:</b> Program Core/Theory Course             | L-T-P-C | 2-0-2-3 |
| <b>Version No.</b>             | 1.0                                                                                                                      |         |         |
| <b>NCrF Level</b>              | 5.0                                                                                                                      |         |         |
| <b>Course Pre-requisites</b>   | Database Management Systems; Probability and Statistics; Exploratory Data Analysis; Computational Thinking using Python. |         |         |
| <b>Co-requisites</b>           | NIL                                                                                                                      |         |         |
| <b>Anti-requisites</b>         | NIL                                                                                                                      |         |         |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                              |            |
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| CourseDescription                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | This course introduces the concepts, techniques, and tools used in Business Intelligence (BI) and Analytics for data-driven decision making. It covers data warehousing, data preprocessing, OLAP operations, and types of analytics including descriptive, predictive, and prescriptive analytics. The course emphasizes hands-on learning using tools such as Power BI and Python to analyze data, build dashboards, and generate insights for real-world applications.                                                                                                                                                                                                                                                                                                                  |                                                                                              |            |
| CourseObjective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | To enable students to understand and apply business intelligence and analytics techniques for data analysis, visualization, and decision making through practical learning.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                              |            |
| CourseOutcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | On successful completion of the course the students shall be able to:<br><b>CO1:</b> Explain the concepts, architecture, and components [Level 2 – Understand] of business intelligence and data warehousing systems.<br><b>CO2:</b> Apply data preprocessing, transformation, and [Level 3 – Apply] OLAP operations for business data analysis<br><b>CO3:</b> Analyze datasets using visualization techniques and [Level 4 – Analyze] reporting tools to generate meaningful insights.<br><b>CO4:</b> Analyze different types of analytics including [Level 4 – Analyze] descriptive, predictive, and prescriptive analytics for business decision making.<br><b>CO5:</b> Analyze business intelligence solutions using [Level 4 – Analyze] analytical tools for real-world applications. |                                                                                              |            |
| CourseContent:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                              |            |
| Module 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Introduction to Business Intelligence and Data Warehousing                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Assessment: Quiz + Assignment (BI Architecture and Data Warehousing Concepts)                | 6 Sessions |
| Introduction to Business Intelligence and Analytics; BI architecture and components; Data warehousing concepts and characteristics; ETL process ( <i>extract, transform, load</i> ); Data warehouse schemas ( <i>star and snowflake</i> ); Data integrity and data quality.                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                              |            |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Data Preparation and OLAP Operations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Assessment: Programming Assignment (Data Preprocessing and OLAP Operations using SQL/Python) | 6 Sessions |
| Data preprocessing and cleaning (handling missing values, removal of duplicates, basic outlier handling, data type conversion, data consistency checks); Data transformation and integration (normalization, standardization, basic encoding, feature creation, data aggregation, merging datasets); Relational data and data modeling (tables, keys, relationships, schema design, star and snowflake overview); OLAP concepts (roll-up, drill-down, slice, dice); Multidimensional data models. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                              |            |
| Module 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Data Visualization and Reporting                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Assessment: Assignment (Dashboard and Reporting using Power BI/Tableau)                      | 6 Sessions |

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| Principles of data visualization; Charts and graphs (bar, line, pie); Dashboards and KPI (key performance indicators); Business reporting and storytelling; Interactive dashboards using BI tools (Power BI/Tableau).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                              |                                                                                     |                   |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Data Visualization and Reporting</b>      | <b>Assessment: Assignment (Predictive Analytics and Business Case Study)</b>        | <b>6 Sessions</b> |
| Types of analytics (descriptive, predictive, prescriptive); Predictive analytics (basic regression, forecasting); Introduction to machine learning in BI (overview); Business applications (finance, marketing, operations, supply chain); Case studies and real-world scenarios.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                              |                                                                                     |                   |
| <b>Module 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Advanced BI Tools and Emerging Trends</b> | <b>Assessment: Mini Project (Cloud-Based BI and Advanced Analytics Application)</b> | <b>6 Sessions</b> |
| Advanced features in BI tools (Power BI/Tableau advanced visualizations, DAX basics, calculated fields); Introduction to Big Data in BI (concepts of Hadoop and Spark – overview); Cloud-based BI solutions (Azure, Google BI tools – basics); Real-time data analytics and streaming concepts; Data governance, security, and ethics in BI; Introduction to AI-powered BI and automation in reporting.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                              |                                                                                     |                   |
| <p><b>List of Laboratory Tasks:</b></p> <p><b>Lab 1. Introduction to BI Tools (Power BI Interface)</b><br/>Install and explore Power BI environment. Import a sample dataset and understand fields, data types, and layout.</p> <p><b>Lab 2. Data Loading and Exploration</b><br/>Load a dataset into Power BI/Excel and perform basic exploration such as viewing summaries and identifying key variables.</p> <p><b>Lab 3. Basic Data Quality Check</b><br/>Identify missing values, duplicates, and inconsistencies in the dataset. Perform simple corrections.</p> <p><b>Lab 4. Data Cleaning using Power Query</b><br/>Handle missing values, remove duplicates, and clean raw data using Power Query tools.</p> <p><b>Lab 5. Data Transformation</b><br/>Apply transformations such as filtering, sorting, creating new columns, and formatting data.</p> <p><b>Lab 6. Data Integration (Merging Datasets)</b><br/>Combine two datasets using joins (inner/left join) and analyze the merged data.</p> <p><b>Lab 7. Data Modeling and Relationships</b><br/>Create relationships between tables and understand primary and foreign keys in BI tools.</p> <p><b>Lab 8. OLAP Operations</b><br/>Perform roll-up, drill-down, slice, and dice operations on data using BI tools.</p> <p><b>Lab 9. Basic Charts Creation</b><br/>Create bar charts, pie charts, and line charts to visualize business data.</p> <p><b>Lab 10. KPI Creation</b><br/>Design KPI indicators such as total sales, profit, and growth rate.</p> |                                              |                                                                                     |                   |

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| <b>Lab 11. Dashboard Development</b><br>Build an interactive dashboard combining multiple visuals and filters.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                         |
| <b>Lab 12. Report Generation</b><br>Generate a business report with visual insights and interpretations.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                         |
| <b>Lab 13. Descriptive Analytics</b><br>Analyze trends and patterns in data using visualizations and summary statistics.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                         |
| <b>Lab 14. Basic Predictive Analysis</b><br>Use built-in forecasting tools (Power BI/Excel) to predict future trends.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                         |
| <b>Lab 15. Mini Project: BI Solution</b><br>Perform end-to-end analysis: <ul style="list-style-type: none"> <li>• Data preprocessing</li> <li>• Dashboard creation</li> <li>• Insights generation</li> <li>• Business recommendations</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                         |
| <b>Targeted Applications &amp; Tools:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                         |
| <b>Power BI / Tableau</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Data visualization, dashboard creation, and business reporting.                         |
| <b>SQL / MySQL</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Data querying, data extraction, and database management                                 |
| <b>Python (NumPy, pandas)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Data preprocessing, analysis, and numerical computation                                 |
| <b>Jupyter Notebook / Google Colab</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Interactive environment for implementing, testing, and documenting analytics workflows. |
| <b>Excel</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Business reporting, basic analytics, and data summarization.                            |
| <b>Power Query</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Data cleaning, transformation, and integration                                          |
| <b>Skill-Building Activities through Experiential Learning:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                         |
| <ul style="list-style-type: none"> <li>• <b>Data Preparation and Cleaning:</b><br/>Students perform data preprocessing tasks including handling missing values, removing duplicates, and transforming raw data into analysis-ready formats using tools such as Power BI and Python.</li> <li>• <b>Dashboard and Visualization Development:</b><br/>Learners design interactive dashboards and visual reports using Power BI/Tableau to represent business KPIs and trends effectively.</li> <li>• <b>Business Data Analysis:</b><br/>Students analyze datasets to identify patterns, trends, and insights using descriptive analytics techniques.</li> <li>• <b>Predictive Analysis (Basic):</b><br/>Learners apply basic forecasting and trend analysis techniques using BI tools to understand future business outcomes.</li> <li>• <b>Mini Project – Business Intelligence Solution:</b><br/>Students develop a complete BI solution involving data preparation, visualization, and insight generation for real-world business scenarios.</li> </ul> |                                                                                         |

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| <b>Textbooks</b><br><br><b>T1:</b> Efraim Turban, Ramesh Sharda, Dursun Delen – <i>Business Intelligence, Analytics, and Data Science</i> , Pearson.<br><b>T2:</b> Bart Baesens – <i>Analytics in a Big Data World</i> , Wiley.                                                                                                                                                                                                                                                                                         |
| <b>References</b><br><b>R1:</b> Aurélien Géron – <i>Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow</i> , O'Reilly.<br><b>R2:</b> Cole Nussbaumer Knaflitz – <i>Storytelling with Data</i> , Wiley.<br><b>R3:</b> Thomas H. Davenport – <i>Analytics at Work</i> , Harvard Business Review Press.                                                                                                                                                                                                    |
| <b>E-Resources/WebResources</b> <ul style="list-style-type: none"> <li>• <a href="https://powerbi.microsoft.com">https://powerbi.microsoft.com</a></li> <li>• <a href="https://www.tableau.com/learn">https://www.tableau.com/learn</a></li> <li>• <a href="https://www.kaggle.com">https://www.kaggle.com</a></li> <li>• <a href="https://pandas.pydata.org">https://pandas.pydata.org</a></li> <li>• <a href="https://learn.microsoft.com/en-us/power-bi/">https://learn.microsoft.com/en-us/power-bi/</a></li> </ul> |

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| <b>CourseCode:</b><br><b>ADS3412</b> | <b>Course Name:</b> Predictive Analytics<br><br><b>Type of Course:</b> Theory & Laboratory Int Course                                                                                                                                                                                                                                                                                                                                                      | <b>L-T-P-C</b> | 2-0-2-3 |
| <b>VersionNo.</b>                    | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                |         |
| <b>NCrFLLevel</b>                    | 5.0                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                |         |
| <b>CoursePre-requisites</b>          | Probability and Statistics; Exploratory Data Analysis; Computational Thinking using Python                                                                                                                                                                                                                                                                                                                                                                 |                |         |
| <b>Co-requisites</b>                 | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                |         |
| <b>Anti-requisites</b>               | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                |         |
| <b>CourseDescription</b>             | This course introduces the concepts and techniques of predictive analytics for analyzing data and forecasting future outcomes. It focuses on data preprocessing, exploratory data analysis, regression and classification models, and model evaluation techniques. The course emphasizes hands-on learning using Python and visualization tools to build predictive models and apply them to real-world applications in business, healthcare, and finance. |                |         |
| <b>CourseObjective</b>               | To enable students to understand and apply predictive analytics techniques for data analysis, model building, and forecasting through practical and experiential learning.                                                                                                                                                                                                                                                                                 |                |         |

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| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                           | On successful completion of the course the student shall be able to:                                    |                                                                                                   |            |
|                                                                                                                                                                                                                                                                                                                                                                                                                           | C01: Explain the fundamental concepts and importance of predictive analytics. [Level 2 – Understand]    |                                                                                                   |            |
|                                                                                                                                                                                                                                                                                                                                                                                                                           | C02: Apply data preprocessing and exploratory data analysis techniques on datasets. [Level 3 – Apply]   |                                                                                                   |            |
|                                                                                                                                                                                                                                                                                                                                                                                                                           | C03: Apply predictive models such as regression and classification for data analysis. [Level 3 – Apply] |                                                                                                   |            |
|                                                                                                                                                                                                                                                                                                                                                                                                                           | C04: Analyze predictive models using evaluation metrics and validation techniques. [Level 4 – Analyze]  |                                                                                                   |            |
| C05: Analyze predictive analytics solutions for real-world applications. [Level 4 – Analyze]                                                                                                                                                                                                                                                                                                                              |                                                                                                         |                                                                                                   |            |
| Course Content:                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                         |                                                                                                   |            |
| Module 1                                                                                                                                                                                                                                                                                                                                                                                                                  | Introduction to Predictive Analytics and Data Preparation                                               | Assessment: Quiz + Assignment (Data Preprocessing and Exploratory Data Analysis using Python)     | 6 Sessions |
| Introduction to predictive analytics (definition, importance, applications); Types of analytics (descriptive, predictive); Data collection and sources (structured, unstructured data); Data preprocessing (handling missing values, duplicate removal, outlier detection, normalization); Exploratory data analysis (summary statistics, correlation analysis); Data visualization (bar chart, histogram, scatter plot). |                                                                                                         |                                                                                                   |            |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                                                  | Classical Machine Learning for Prediction                                                               | Assessment: Programming Assignment (Regression Models and Prediction Analysis)                    | 6 Sessions |
| Simple linear regression (model formulation, coefficient interpretation); Multiple linear regression (multiple features, assumptions); Model assumptions (linearity, independence, normality); Model evaluation ( $R^2$ , RMSE, residual analysis); Feature selection (basic techniques); Applications of regression (sales prediction, trend analysis).                                                                  |                                                                                                         |                                                                                                   |            |
| Module 3                                                                                                                                                                                                                                                                                                                                                                                                                  | Deep Learning and Advanced Models                                                                       | Assessment: Assignment (Classification Models using Logistic Regression, Decision Trees, and KNN) | 6 Sessions |
| Classification concepts (binary and multi-class classification); Logistic regression (sigmoid function, decision boundary); Decision trees (splitting criteria, tree structure); k-Nearest Neighbors (distance metrics, K selection); Confusion matrix (TP, TN, FP, FN); Evaluation metrics (accuracy, precision, recall, F1-score).                                                                                      |                                                                                                         |                                                                                                   |            |
| Module 4                                                                                                                                                                                                                                                                                                                                                                                                                  | Prescriptive Analytics and Optimization                                                                 | Assessment: Assignment (Model Validation and Ensemble Learning Techniques)                        | 6 Sessions |
| Model validation techniques (train-test split, cross-validation); Overfitting and underfitting (bias-variance tradeoff); Model tuning (basic hyperparameter tuning); Introduction to ensemble methods (random forest – overview); Applications (business forecasting, healthcare prediction, finance analytics).                                                                                                          |                                                                                                         |                                                                                                   |            |
| Module 5                                                                                                                                                                                                                                                                                                                                                                                                                  | Deployment, Model Interpretation, and Real-World Applications                                           | Assessment: Mini Project (End-to-End Predictive Analytics Application)                            | 6 Sessions |

Model deployment basics (introduction to deployment, APIs, batch vs real-time predictions); Introduction to tools for deployment (Flask/Streamlit – basics); Model interpretability (feature importance, SHAP/LIME – overview); Ethical considerations in predictive analytics (bias, fairness, transparency); Monitoring and maintaining models (model drift, performance tracking); Case studies and mini projects (end-to-end predictive analytics workflow).

### List of Laboratory Tasks:

#### Lab 1. Data Preprocessing

Handle missing values, remove duplicates, and perform basic data cleaning.

#### Lab 2. Outlier Detection

Identify and treat outliers using statistical techniques.

#### Lab 3. Exploratory Data Analysis (EDA)

Visualize patterns and relationships using charts and summary statistics.

#### Lab 4. Simple Linear Regression

Build a regression model and interpret coefficients.

#### Lab 5. Multiple Linear Regression

Apply regression with multiple features and analyze results.

#### Lab 6. Regression Model Evaluation

Evaluate model using  $R^2$  and RMSE metrics.

#### Lab 7. Feature Selection (Basic)

Identify important features and analyze their impact.

#### Lab 8. Logistic Regression

Implement classification for binary outcomes.

#### Lab 9. Decision Tree Model

Build and visualize a decision tree classifier.

#### Lab 10. k-NN Algorithm

Implement k-nearest neighbors and analyze predictions.

#### Lab 11. Classification Model Evaluation

Evaluate using confusion matrix, precision, recall, and F1-score.

#### Lab 12. Model Validation Techniques

Perform train-test split and cross-validation.

#### Lab 13. Overfitting and Underfitting Analysis

Analyze model performance under different scenarios.

#### Lab 14. Ensemble Method (Basic)

Implement random forest and compare models.

#### Lab 15. Mini Project: Predictive Analytics Solution

End-to-end model building, evaluation, and interpretation.

### Targeted Applications & Tools:

|                    |                                         |
|--------------------|-----------------------------------------|
| IDEs               | Jupyter Notebook, Google Colab, VS Code |
| Power BI / Tableau | Data visualization and reporting        |

|                                                                                                                                                                                                                                                                                                               |                                            |
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| <b>Python (NumPy, pandas, scikit-learn)</b>                                                                                                                                                                                                                                                                   | Data preprocessing and predictive modeling |
| <b>Excel</b>                                                                                                                                                                                                                                                                                                  | Basic data analysis and preprocessing      |
| <b>Skill-Building Activities through Experiential Learning:</b>                                                                                                                                                                                                                                               |                                            |
| <ul style="list-style-type: none"> <li>• Data preprocessing and exploratory data analysis</li> <li>• Regression and classification model building</li> <li>• Model evaluation and validation</li> <li>• Predictive analysis on real-world datasets</li> <li>• Mini project on predictive analytics</li> </ul> |                                            |
| <b>Textbooks</b>                                                                                                                                                                                                                                                                                              |                                            |
| <b>T1: Gareth James et al. - <i>An Introduction to Statistical Learning</i>, Springer</b><br><b>T2: Evans, J. R. - <i>Business Analytics</i>, Pearson</b>                                                                                                                                                     |                                            |
| <b>References</b>                                                                                                                                                                                                                                                                                             |                                            |
| <b>R1: Aurélien Géron - <i>Hands-On Machine Learning</i>, O'Reilly</b><br><b>R2: Provost &amp; Fawcett - <i>Data Science for Business</i>, O'Reilly</b><br><b>R3: Sharda, Delen &amp; Turban - <i>Analytics, Data Science and AI</i>, Pearson</b>                                                             |                                            |
| <b>E-Resources/WebResources</b>                                                                                                                                                                                                                                                                               |                                            |
| <a href="https://scikit-learn.org">https://scikit-learn.org</a><br><a href="https://www.tensorflow.org">https://www.tensorflow.org</a><br><a href="https://pytorch.org">https://pytorch.org</a><br><a href="https://www.kaggle.com">https://www.kaggle.com</a>                                                |                                            |

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| <b>Course Code:</b><br>ADS3413 | <b>Course Name:</b> Financial Data Analytics<br><br><b>Type of Course:</b> Theory & Laboratory Int Course                                                                                                                                                                                                                                                                                                                              | <b>L-T-P-C</b> | 2-0-2-3 |
| <b>Version No.</b>             | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                    |                |         |
| <b>NCrF Level</b>              | 5.0                                                                                                                                                                                                                                                                                                                                                                                                                                    |                |         |
| <b>Course Pre-requisites</b>   | Probability and Statistics; Database Management Systems; Exploratory Data Analysis; Basics of Finance                                                                                                                                                                                                                                                                                                                                  |                |         |
| <b>Co-requisites</b>           | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                    |                |         |
| <b>Anti-requisites</b>         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                    |                |         |
| <b>Course Description</b>      | This course introduces the fundamentals of financial data analytics for analyzing financial data and supporting decision making. It covers financial statement analysis, basic financial modelling, risk analysis, and introductory predictive analytics techniques. The course emphasizes hands-on learning using tools such as Excel, Python, and Power BI to solve real-world problems in banking, investment, and finance domains. |                |         |

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| CourseObjective                                                                                                                                                                                                                                                                                                                                                      | To enable students to understand and apply financial data analytics techniques for analyzing financial data, visualizing insights, and supporting data-driven financial decision making.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                              |            |
| CourseOutcomes                                                                                                                                                                                                                                                                                                                                                       | Onsuccessfulcompletionofthecoursethestudentsshallbeableto:<br><br>CO1: Explain the basic concepts of financial data analysis including financial statements and time value of money. [Level 2 – Understand]<br>CO2: Apply financial analysis techniques such as ratio analysis, basic valuation, and portfolio concepts. [Level 3 – Apply]<br>CO3: Analyze financial datasets using visualization and statistical techniques to identify trends and patterns. [Level 4 – Analyze]<br>CO4: Analyze basic predictive models such as regression and classification for financial applications. [Level 4 – Analyze]<br>CO5: Analyze simple financial analytics solutions using analytical tools for real-world applications. [Level 4 – Analyze] |                                                                                                                                                                              |            |
| CourseContent:                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                              |            |
| Module 1                                                                                                                                                                                                                                                                                                                                                             | Financial Data and Statement Analysis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Assessment: Assignment / Case Study – Analysis of financial statements and calculation of key financial ratios from sample datasets.                                         | 6 Sessions |
| Introduction to financial data analytics; Financial statements (balance sheet, income statement, cash flow statement); Financial ratios (liquidity, profitability, efficiency); Interlinking of financial statements; Time value of money (present value, future value, annuities – basics), Introduction to financial datasets (structured financial data sources); |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                              |            |
| Module 2                                                                                                                                                                                                                                                                                                                                                             | Financial Modelling and Valuation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Assessment: Practical Lab / Project – Build simple financial models in Excel for valuation, capital budgeting, and portfolio analysis.                                       | 6 Sessions |
| Equity and bond basics (valuation concepts, risk and return); Portfolio basics (risk, return, diversification – overview); Capital budgeting (NPV, IRR, payback period – basics); Business valuation (discounted cash flow – basic idea); Introduction to financial modelling using Excel (basic functions and calculations).                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                              |            |
| Module 3                                                                                                                                                                                                                                                                                                                                                             | Risk Analysis and Financial Analytics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Assessment: Quiz + Assignment – Calculate and interpret Value at Risk (VaR); Create dashboards for risk visualization; analyze capital structure and derivative instruments. | 6 Sessions |
| Risk and return concepts; Value at Risk (basic concepts and interpretation); Introduction to financial derivatives (forwards, futures, options – basics); Basics of capital structure; Financial risk analysis and interpretation.Introduction to risk visualization (charts and dashboards).                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                              |            |
| Module 4                                                                                                                                                                                                                                                                                                                                                             | Predictive Analytics in Finance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Assessment: Programming Assignment / Mini                                                                                                                                    | 6 Sessions |

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| Introduction to predictive analytics; Regression (linear regression – basic idea); Classification (logistic regression – basic idea); Decision trees (basic concepts); Applications in finance (credit risk, fraud detection, investment analysis); Introduction to data-driven decision making.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                          |                                                                                                                                                                                                       |            |
| Module 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Financial Technology (FinTech) and Advanced Applications | Assessment: Case Study / Mini Project – Explore FinTech applications including blockchain, algorithmic trading, robo-advisory, and implement visualization of financial data using Excel or Power BI. | 6 sessions |
| Introduction to FinTech (concepts and evolution); Digital payments and online banking systems; Basics of blockchain and cryptocurrencies (overview and applications in finance); Algorithmic trading (basic concepts and strategies); Introduction to robo-advisory and automated investment platforms; Financial data visualization using tools (Excel/Power BI – advanced features); Ethical and regulatory issues in financial analytics; Case studies on modern financial systems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                          |                                                                                                                                                                                                       |            |
| <p><b>List of Laboratory Tasks:</b></p> <p><b>Lab 1. Financial Dataset Exploration</b><br/>Import a financial dataset into Excel/Python and identify key attributes such as revenue, expenses, assets, and liabilities. Understand the structure and types of financial data.</p> <p><b>Lab 2. Financial Statement Analysis</b><br/>Analyze sample balance sheet and income statement data to understand financial position and performance. Identify relationships between different components.</p> <p><b>Lab 3. Ratio Analysis using Excel</b><br/>Compute key financial ratios such as liquidity, profitability, and efficiency ratios using Excel. Interpret the results to evaluate company performance.</p> <p><b>Lab 4. Time Value of Money Calculation</b><br/>Calculate present value and future value of cash flows using Excel formulas. Understand the impact of interest rates and time on investments.</p> <p><b>Lab 5. Loan and EMI Calculation</b><br/>Implement loan amortization and EMI calculations using Excel functions. Analyze repayment schedules and interest components.</p> <p><b>Lab 6. Capital Budgeting Analysis</b><br/>Evaluate investment projects by calculating NPV, IRR, and payback period. Compare different projects for decision making.</p> <p><b>Lab 7. Portfolio Analysis</b><br/>Compute expected return and risk (variance/standard deviation) for a simple portfolio. Understand diversification effects.</p> <p><b>Lab 8. Financial Modelling in Excel</b></p> |                                                          |                                                                                                                                                                                                       |            |

Build a basic financial model using Excel formulas for revenue, cost, and profit estimation. Perform simple scenario analysis.

#### **Lab 9. Risk-Return Analysis**

Plot and analyze risk vs return using financial data. Use charts to understand trade-offs between risk and expected returns.

#### **Lab 10. Value at Risk (VaR) – Basic Implementation**

Estimate Value at Risk using historical data with a simple method. Interpret potential financial losses under risk scenarios.

#### **Lab 11. Financial Data Visualization Dashboard**

Create an interactive dashboard using Power BI/Tableau to visualize KPIs, trends, and financial performance.

#### **Lab 12. Derivatives Basics Simulation**

Simulate payoff for basic financial derivatives such as call and put options using Excel. Understand profit/loss behavior.

#### **Lab 13. Regression Analysis using Python**

Implement a basic linear regression model on financial data to predict values such as sales or returns. Interpret model results.

#### **Lab 14. Classification Model (Credit Risk)**

Apply logistic regression to classify outcomes such as loan approval or default risk. Evaluate model accuracy.

#### **Lab 15. Mini Project: Financial Analytics Solution**

Perform an end-to-end analysis including data preprocessing, financial analysis, visualization, and interpretation. Present insights and recommendations.

#### **Targeted Applications & Tools:**

|                                      |                                                                 |
|--------------------------------------|-----------------------------------------------------------------|
| <b>MS Excel</b>                      | Financial modelling, ratio analysis, and valuation calculations |
| <b>Python (Pandas, NumPy)</b>        | Financial data preprocessing and analysis                       |
| <b>Power BI / Tableau</b>            | Financial dashboards and visualization.                         |
| <b>SQL / MySQL</b>                   | Data querying and management                                    |
| <b>Jupyter Notebook/Google Colab</b> | Implementing and testing analytics workflows                    |

#### **Skill-Building Activities through Experiential Learning:**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
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| <ul style="list-style-type: none"> <li>• <b>Financial Statement Analysis:</b><br/>Students analyze real-world financial datasets to understand balance sheets, income statements, cash flows, and compute key financial ratios for performance evaluation.</li> <li>• <b>Financial Modelling using Excel:</b><br/>Learners perform basic financial modelling tasks such as time value of money calculations, investment analysis, and valuation using Excel functions and formulas.</li> <li>• <b>Dashboard Creation for Financial Data:</b><br/>Students design interactive dashboards using Power BI/Tableau to visualize financial trends, KPIs, and business performance indicators.</li> <li>• <b>Risk Analysis and Interpretation:</b><br/>Learners analyze financial risk using basic concepts such as risk–return relationships and interpret results using charts and visual tools.</li> </ul> |
| <b>Textbooks</b><br><br><b>T1:</b> Simon Benninga – <i>Financial Modeling</i> , MIT Press<br><b>T2:</b> John Hull – <i>Fundamentals of Financial Management</i> , Wiley                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>References</b><br><b>R1:</b> Zvi Bodie – <i>Investments</i> , McGraw-Hill<br><b>R2:</b> Paul Wilmott – <i>Quantitative Finance (Basic Concepts)</i><br><b>R3:</b> Aurélien Géron – <i>Hands-On Machine Learning</i> , O'Reilly                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>E-Resources/WebResources</b> <ol style="list-style-type: none"> <li>1. <a href="https://www.investopedia.com">https://www.investopedia.com</a></li> <li>2. <a href="https://www.kaggle.com">https://www.kaggle.com</a></li> <li>3. <a href="https://pandas.pydata.org">https://pandas.pydata.org</a></li> <li>4. <a href="https://powerbi.microsoft.com">https://powerbi.microsoft.com</a></li> <li>5. <a href="https://www.risk.net">https://www.risk.net</a></li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                            |

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|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|---------|
| <b>CourseCode:</b> ADS3414  | <b>CourseTitle:</b> Marketing and Customer Analytics<br><b>Type of Course:</b> Theory Course                                                                                                                                                                                         | <b>L-T-P-C</b> | 2-0-2-3 |
| <b>VersionNo.</b>           | 1.0                                                                                                                                                                                                                                                                                  |                |         |
| <b>NCrFLevel-</b>           | 5.0                                                                                                                                                                                                                                                                                  |                |         |
| <b>Coursepre-requisites</b> | Introduction to Data Science, Statistical Foundations of Data Science                                                                                                                                                                                                                |                |         |
| <b>Co-requisites</b>        | -                                                                                                                                                                                                                                                                                    |                |         |
| <b>Anti-requisites</b>      | NIL                                                                                                                                                                                                                                                                                  |                |         |
| <b>CourseDescription</b>    | This course introduces the concepts and techniques of marketing analytics and customer intelligence using data science approaches. It focuses on customer segmentation, predictive modeling, recommendation systems, and data-driven marketing strategies using real-world datasets. |                |         |
| <b>CourseObjective</b>      | To enable learners to apply data science and machine learning techniques for analyzing customer behavior and improving marketing decisions.                                                                                                                                          |                |         |

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| CourseOutcomes                                                                                                                                                                                                                                                                                                                                                                                                          | On successful completion of the course the students shall be able to:                              |                                                                                                                         |            |
|                                                                                                                                                                                                                                                                                                                                                                                                                         | C01: Understand marketing analytics concepts and[Level 2 customer behavior. Understand]            |                                                                                                                         |            |
|                                                                                                                                                                                                                                                                                                                                                                                                                         | C02: Apply clustering and classification techniques for[Level 3 – Apply] customer segmentation.    |                                                                                                                         |            |
|                                                                                                                                                                                                                                                                                                                                                                                                                         | C03: Apply predictive models for marketing[Level 3 – Apply] applications such as churn prediction. |                                                                                                                         |            |
|                                                                                                                                                                                                                                                                                                                                                                                                                         | C04: Analyze customer data and marketing strategies. [Level 4 – Analyze]                           |                                                                                                                         |            |
| C05: Analyze marketing performance using analytics[Level 4 – Analyze] tools.                                                                                                                                                                                                                                                                                                                                            |                                                                                                    |                                                                                                                         |            |
| CourseContent:                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                    |                                                                                                                         |            |
| Module 1                                                                                                                                                                                                                                                                                                                                                                                                                | Foundations of Marketing Analytics                                                                 | Assessment: Quiz + Assignment – Marketing analytics concepts, customer lifecycle, metrics (CLV, CAC), and data sources. | 6 Sessions |
| Introduction to marketing analytics in data science – Role of analytics in engineering decision systems – Customer lifecycle modeling and journey analytics – Types of analytics: Descriptive, Predictive, Prescriptive – Data sources: CRM systems, web logs, social media data – Key metrics: Customer Lifetime Value (CLV), Customer Acquisition Cost (CAC) – Introduction to marketing data pipelines and workflow. |                                                                                                    |                                                                                                                         |            |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                                                | Customer Data Management and Preprocessing                                                         | Assessment: Assignment – Data cleaning, preprocessing, transformation, and feature engineering using Python.            | 6 Sessions |
| Customer data acquisition and integration – Data cleaning techniques (handling missing values, noise, outliers) – Data transformation and normalization – Feature engineering for customer analytics – Data preprocessing using Python (pandas, NumPy) – Data quality management and data consistency.                                                                                                                  |                                                                                                    |                                                                                                                         |            |
| Module 3                                                                                                                                                                                                                                                                                                                                                                                                                | Customer Segmentation and Profiling using ML                                                       | Assessment: Programming Assignment – Customer segmentation using K-Means, Hierarchical clustering, and RFM analysis.    | 6 Sessions |
| Market segmentation concepts – Clustering algorithms: K-Means, Hierarchical clustering – RFM analysis – Customer profiling and persona modeling – Behavioral and demographic segmentation – Evaluation and interpretation of segmentation results.                                                                                                                                                                      |                                                                                                    |                                                                                                                         |            |
| Module 4                                                                                                                                                                                                                                                                                                                                                                                                                | Predictive Modeling for Marketing Applications                                                     | Assessment: Assignment – Churn prediction, recommendation systems, and model evaluation (precision, recall, F1-score).  | 6 Sessions |
| Customer churn prediction – Recommendation systems (Collaborative and Content-based filtering) – Supervised learning models: Logistic Regression, Decision Trees – Model evaluation metrics (Accuracy, Precision, Recall, F1-score) – A/B testing and experimental design – Model performance optimization.                                                                                                             |                                                                                                    |                                                                                                                         |            |
| Module 5                                                                                                                                                                                                                                                                                                                                                                                                                | AI-Driven Marketing Systems and Case Studies                                                       | Assessment: Mini Project – Sentiment analysis,                                                                          | 6 Sessions |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  | recommendation systems, and case studies in marketing analytics. |  |
| <p>Digital marketing analytics – Sentiment analysis using NLP – Personalized recommendation systems – Case studies: E-commerce, Banking, Retail – Ethical and privacy issues in customer data – Emerging trends in AI-driven marketing.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |                                                                  |  |
| <p><b>List of Laboratory Tasks:</b></p> <p>Lab 1: Introduction to Marketing Data</p> <p>Understand different types of marketing data such as customer data, transactional data, and behavioral data. Explore datasets used in marketing analytics.</p> <p>Lab 2: Data Loading and Exploration</p> <p>Load marketing datasets using Python (pandas) and perform basic exploratory data analysis to understand structure, features, and data distribution.</p> <p>Lab 3: Data Cleaning and Preprocessing</p> <p>Handle missing values, remove duplicates, and preprocess marketing data. Perform normalization and transformation of data.</p> <p>Lab 4: Feature Engineering for Customer Data</p> <p>Create new features such as customer age groups, purchase frequency, and spending patterns for analysis.</p> <p>Lab 5: Customer Segmentation using K-Means</p> <p>Apply K-Means clustering to segment customers based on behavior and purchasing patterns.</p> <p>Lab 6: Hierarchical Clustering for Segmentation</p> <p>Perform hierarchical clustering and compare results with K-Means clustering for customer segmentation.</p> <p>Lab 7: RFM Analysis</p> <p>Implement Recency, Frequency, and Monetary (RFM) analysis to classify customers into different segments.</p> <p>Lab 8: Customer Profiling and Visualization</p> <p>Visualize customer segments using charts and graphs. Analyze patterns and create customer profiles.</p> <p>Lab 9: Churn Prediction using Logistic Regression</p> <p>Build a churn prediction model using logistic regression and evaluate model performance.</p> <p>Lab 10: Customer Classification using Decision Trees</p> <p>Implement decision tree classifier to predict customer behavior and compare results with other models.</p> <p>Lab 11: Recommendation System (Basic)</p> <p>Develop a simple recommendation system using collaborative or content-based filtering techniques.</p> |  |                                                                  |  |

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| <p>Lab 12: Marketing Campaign Analysis</p> <p>Analyze marketing campaign data and evaluate performance using metrics such as conversion rate and ROI.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                               |
| <p>Lab 13: A/B Testing Implementation</p> <p>Perform A/B testing to compare marketing strategies and analyze results statistically.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                               |
| <p>Lab 14: Dashboard Creation for Marketing Insights</p> <p>Create dashboards using Power BI or Tableau to visualize customer insights and marketing performance.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                               |
| <p>Lab 15: Mini Project – End-to-End Marketing Analytics</p> <p>Develop a complete marketing analytics solution including data preprocessing, segmentation, prediction, and visualization.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                               |
| <b>Targeted Applications &amp; Tools:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                               |
| <b>Python (NumPy, pandas)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Data preprocessing, customer data analysis                    |
| <b>Scikit-learn (sklearn)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Customer segmentation, classification, recommendation systems |
| <b>NLP Libraries (NLTK, spaCy)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Sentiment analysis and text analytics                         |
| <b>Matplotlib &amp; Seaborn</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Visualization of customer insights and trends                 |
| <b>Tableau / Power BI</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Dashboard creation and marketing analytics visualization      |
| <b>Skill-Building Activities through Experiential Learning:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                               |
| <ul style="list-style-type: none"> <li>• Customer Segmentation and Profiling<br/>Students perform clustering and segmentation using real-world datasets to identify customer groups.</li> <li>• Predictive Modeling in Marketing<br/>Learners build churn prediction and recommendation models using machine learning algorithms.</li> <li>• Marketing Data Analysis and Visualization<br/>Students analyze customer data and create dashboards to derive actionable insights.</li> <li>• Real-world Case Study Development<br/>Learners develop marketing analytics solutions for domains such as e-commerce and finance.</li> </ul> |                                                               |
| <b>Textbooks</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                               |
| <p><b>T1:</b> Stephan Sorger, “Marketing Analytics: Strategic Models and Metrics”, Publisher: CreateSpace Independent Publishing Platform, 2017.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                               |
| <p><b>T2:</b> Wayne L. Winston, “Marketing Analytics: Data-Driven Techniques with Microsoft Excel”, Publisher: Wiley, 2014.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                               |

|                                 |                                                                                                                                                               |                |           |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-----------|
| <b>References</b>               |                                                                                                                                                               |                |           |
| 1.                              | Foster Provost and Tom Fawcett, "Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking", O'Reilly Media, 2013.        |                |           |
| 2.                              | Rajkumar Venkatesan, Paul Farris, and Ronald Wilcox, "Cutting Edge Marketing Analytics: Real World Cases and Data Sets for Hands-On Learning", Pearson, 2015. |                |           |
| 3.                              | Eric Siegel, "Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die", Wiley, 2016.                                                      |                |           |
| 4.                              | Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.                                                                            |                |           |
| 5.                              | Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.                                                                            |                |           |
| <b>E-Resources/WebResources</b> |                                                                                                                                                               |                |           |
| 1.                              | Google                                                                                                                                                        | Analytics      | Academy   |
|                                 | <a href="https://analytics.google.com">https://analytics.google.com</a>                                                                                       |                |           |
| 2.                              | Coursera                                                                                                                                                      | Marketing      | Analytics |
|                                 | <a href="https://www.coursera.org">https://www.coursera.org</a>                                                                                               |                |           |
| 3.                              | NPTEL                                                                                                                                                         | Data Analytics | Courses   |
|                                 | <a href="https://nptel.ac.in">https://nptel.ac.in</a>                                                                                                         |                |           |

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| CourseCode:ADS3415   | CourseTitle:Data Visualization and Storytelling<br>Type ofCourse: TheoryCourse                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | L-T-P-C | 2-0-2-3 |
| VersionNo.           | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |         |         |
| NCrFLevel-           | 5.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |         |         |
| Coursepre-requisites | Data Handling and Visualization, Introduction to Data Science                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         |         |
| Co-requisites        | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |         |         |
| Anti-requisites      | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |         |         |
| CourseDescription    | This course focuses on visualization and interpretation of data in the context of Artificial Intelligence and Data Science. It covers data visualization techniques, exploratory data analysis, interactive dashboards, and storytelling methods to communicate insights from machine learning models and large datasets. Students will use tools such as Python, Matplotlib, Seaborn, Plotly, Tableau, and Power BI to develop visual analytics solutions.                                                                                                                    |         |         |
| CourseObjective      | To enable learners to apply data visualization, exploratory data analysis, and storytelling techniques for analyzing datasets, interpreting machine learning outputs, and communicating insights effectively in AI-driven applications.                                                                                                                                                                                                                                                                                                                                        |         |         |
| CourseOutcomes       | On successful completion of the course the students shall be able to:<br><br>CO1: Understand visualization principles in data science[Level 2 – Understand] and AI applications.<br>CO2: Apply visualization techniques using Python[Level 3 – Apply] libraries and tools.<br>CO3: Analyze datasets using exploratory data analysis[Level 4 – Analyze] and graphical methods.<br>CO4: Analyze dashboards and visual reports for[Level 4 – Analyze] decision-making systems.<br>CO5: Analyze and communicate insights from data and[Level 4 – Analyze] machine learning models. |         |         |
| CourseContent:       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |         |         |

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| <b>Module 1</b>                                                                                                                                                                                                                                                                                                                                                 | <b>Foundations of Data Visualization in AI &amp; DS</b>     | <b>Assessment: Quiz + Assignment – Basic visualization techniques, design principles, and visualization best practices.</b>            | <b>6 Sessions</b> |
| Role of data visualization in AI and Data Science – Types of data and visualization techniques – Basic plots: Bar, Line, Scatter, Histogram, Heatmaps – Principles of visual design (color, layout, perception) – Visualization for model understanding – Common errors and best practices.                                                                     |                                                             |                                                                                                                                        |                   |
| <b>Module 2</b>                                                                                                                                                                                                                                                                                                                                                 | <b>Data Preparation and Exploratory Data Analysis (EDA)</b> | <b>Assessment: Assignment – Data preprocessing, EDA, feature analysis, and correlation visualization using Python.</b>                 | <b>6 Sessions</b> |
| Data collection and preprocessing – Handling missing values and outliers – Data transformation and normalization – Exploratory Data Analysis using visualization – Feature analysis and correlation visualization – Visualization for data understanding in ML pipelines.                                                                                       |                                                             |                                                                                                                                        |                   |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                 | <b>Visualization using Python and Tools</b>                 | <b>Assessment: Programming Assignment – Visualization using Matplotlib, Seaborn, Plotly, Tableau, and Power BI.</b>                    | <b>6 Sessions</b> |
| Matplotlib and Seaborn for statistical plots – Plotly for interactive visualization – Visualization of ML model results – Dashboard tools: Tableau and Power BI – Designing visual workflows for analytics – Comparative analysis using visual methods.                                                                                                         |                                                             |                                                                                                                                        |                   |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                 | <b>Data Storytelling and Dashboard Design</b>               | <b>Assessment: Assignment – Storytelling with data and dashboard design for decision-making systems.</b>                               | <b>6 Sessions</b> |
| Concept of storytelling with data – Building narratives from datasets – Visualization for decision-making systems – Dashboard design principles – Visual hierarchy and communication – Presenting insights to technical and non-technical audiences.                                                                                                            |                                                             |                                                                                                                                        |                   |
| <b>Module 5</b>                                                                                                                                                                                                                                                                                                                                                 | <b>Advanced Visualization and AI Applications</b>           | <b>Assessment: Mini Project – Advanced visualization techniques, ML performance visualization, and AI-driven analytics case study.</b> | <b>6 Sessions</b> |
| Visualization of high-dimensional data – Real-time and streaming data visualization – Visualization in machine learning (model performance, confusion matrix, ROC curves) – Visualization for big data systems – Ethical and bias issues in visualization – Case studies in AI-driven analytics.                                                                |                                                             |                                                                                                                                        |                   |
| <b>List of Laboratory Tasks:</b><br><br><b>Lab 1: Introduction to Data Visualization</b><br><br>Understand the concept of data visualization and its importance in data science and AI. Study different types of data and basic visualization techniques such as bar charts, line charts, and scatter plots. Identify real-world applications of visualization. |                                                             |                                                                                                                                        |                   |

**Lab 2: Basic Visualization using Python**

Implement basic plots using Python libraries such as Matplotlib. Create bar charts, line graphs, and histograms. Analyze data representation using different visualization techniques.

**Lab 3: Statistical Visualization using Seaborn**

Perform statistical visualization using Seaborn. Create plots such as box plots, violin plots, and heatmaps. Analyze patterns and relationships in data.

**Lab 4: Data Preprocessing for Visualization**

Perform data preprocessing tasks such as handling missing values, removing outliers, and data transformation. Prepare datasets for visualization and analysis.

**Lab 5: Exploratory Data Analysis (EDA)**

Perform exploratory data analysis using visualization techniques. Analyze distributions, correlations, and trends in datasets. Identify key insights from data.

**Lab 6: Interactive Visualization using Plotly**

Create interactive visualizations using Plotly. Develop dynamic charts and dashboards. Analyze user interaction with data.

**Lab 7: Correlation and Feature Analysis**

Visualize relationships between variables using correlation matrices and scatter plots. Analyze feature importance and dependencies in datasets.

**Lab 8: Visualization of Machine Learning Results**

Visualize outputs of machine learning models. Create confusion matrix, accuracy plots, and performance graphs. Analyze model performance using visualization.

**Lab 9: Dashboard Creation using Power BI/Tableau**

Design dashboards using tools such as Power BI or Tableau. Integrate multiple visualizations into a single dashboard. Analyze data insights through dashboards.

**Lab 10: Data Storytelling Techniques**

Understand storytelling with data. Build narratives using visualizations. Present insights in a structured and meaningful way.

**Lab 11: Advanced Visualization Techniques**

Implement advanced visualizations such as heatmaps and multi-dimensional plots. Analyze complex datasets using advanced graphical methods.

**Lab 12: Real-Time Data Visualization**

Visualize real-time or streaming data. Create dynamic dashboards that update continuously. Analyze

trends in real-time data.

### Lab 13: Visualization for Big Data

Perform visualization on large datasets. Use optimized tools and techniques to handle big data visualization. Analyze scalability challenges.

### Lab 14: Ethical and Bias Issues in Visualization

Study ethical considerations in data visualization. Identify misleading visualizations and bias in data representation. Analyze best practices.

### Lab 15: Mini Project – Data Visualization and Storytelling

Develop a complete data visualization project. Perform data analysis, create visualizations, and present insights using storytelling techniques. Use real-world datasets.

### Targeted Applications & Tools:

|                      |                                  |
|----------------------|----------------------------------|
| Python(NumPy,pandas) | Data preprocessing and analysis  |
| Plotly               | Interactive visualization        |
| Matplotlib&Seaborn   | Statistical visualization        |
| Tableau / Power BI   | Dashboard and business analytics |

### Skill-Building Activities through Experiential Learning:

- Exploratory Data Analysis using Python  
Students perform EDA on real-world datasets
- Dashboard Development  
Learners design dashboards using Tableau/Power BI
- Visualization of ML Results  
Students visualize classification and regression outputs
- Data Storytelling Projects  
Students present insights using structured storytelling

### Textbooks

T1: Cole Nussbaumer Knaflitz, “*Storytelling with Data*”, Wiley, 2015

T2: Andy Kirk, “*Data Visualization: A Handbook for Data Driven Design*”, Sage, 2016

|                                                                                                                                                                                                                                                                                                                                    |  |
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| <b>References</b>                                                                                                                                                                                                                                                                                                                  |  |
| <ul style="list-style-type: none"> <li>Edward Tufte, <i>"The Visual Display of Quantitative Information"</i></li> <li>Claus O. Wilke, <i>"Fundamentals of Data Visualization"</i></li> <li>Nathan Yau, <i>"Data Points"</i></li> <li>Hadley Wickham, <i>"ggplot2"</i></li> <li>Alberto Cairo, <i>"The Truthful Art"</i></li> </ul> |  |
| <b>E-Resources/WebResources</b>                                                                                                                                                                                                                                                                                                    |  |
| <ul style="list-style-type: none"> <li>Tableau Learning – <a href="https://www.tableau.com/learn">https://www.tableau.com/learn</a></li> <li>Power BI – <a href="https://learn.microsoft.com">https://learn.microsoft.com</a></li> <li>NPTEL – <a href="https://nptel.ac.in">https://nptel.ac.in</a></li> </ul>                    |  |

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| <b>CourseCode:</b><br>ADS3416 | <b>CourseTitle:</b> Decision Support Systems<br><b>Type ofCourse:</b> TheoryCourse                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>L-T-P-C</b>                                       | 2-0-2-3           |
| <b>VersionNo.</b>             | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                      |                   |
| <b>NCrFLevel-</b>             | 5.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                      |                   |
| <b>Coursepre-requisites</b>   | Database Management Systems, Introduction to Data Science                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                      |                   |
| <b>Co-requisites</b>          | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                      |                   |
| <b>Anti-requisites</b>        | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                      |                   |
| <b>CourseDescription</b>      | This course introduces decision support systems (DSS) and their role in intelligent decision-making using data analytics and artificial intelligence techniques. It covers data management, analytical models, optimization, simulation, and AI-based decision systems. Students will learn to design and implement DSS for real-world applications in business, healthcare, and smart systems.                                                                                                                                                                                       |                                                      |                   |
| <b>CourseObjective</b>        | To enable learners to apply data analytics, machine learning, and decision models for building intelligent decision support systems and solving real-world problems.                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                      |                   |
| <b>CourseOutcomes</b>         | On successful completion of the course the students shall be able to:<br><br><b>CO1:</b> Understand concepts and architecture of decision support systems. [Level 2 – Understand]<br><b>CO2:</b> Apply data-driven and model-driven techniques for decision-making. [Level 3 –Apply]<br><b>CO3:</b> Analyze business and engineering problems using DSS models.. [Level 4 – Analyze]<br><b>CO4:</b> Analyze decision-making techniques and system performance. [Level 4 – Analyze]<br><b>CO5:</b> Analyze intelligent DSS solutions using AI and analytics tools. [Level 4 – Analyze] |                                                      |                   |
| <b>CourseContent:</b>         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                      |                   |
| <b>Module 1</b>               | <b>Foundations of Decision Support Systems</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Assessment:</b> Quiz + Assignment – DSS concepts, | <b>6 Sessions</b> |

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|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------|-------------------|--|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                  | <b>components, architecture, and applications.</b>                                                           | <b>types, and</b> |  |
| Introduction to Decision Support Systems – Role of DSS in AI and Data Science – Components of DSS: Data, Model, User Interface – Types of DSS: Data-driven, Model-driven, Knowledge-driven – DSS architecture and design – Applications of DSS in engineering and business domains.                                                                                                                                                                                                                                                              |                                                  |                                                                                                              |                   |  |
| <b>Module 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Data Management for DSS</b>                   | <b>Assessment: Assignment – Data warehousing, ETL, OLAP operations, and data integration.</b>                | <b>6 Sessions</b> |  |
| Data sources and data integration – Data warehousing concepts – ETL (Extract, Transform, Load) process – OLAP operations (Roll-up, Drill-down, Slice, Dice) – Introduction to data mining – Role of big data in DSS.                                                                                                                                                                                                                                                                                                                             |                                                  |                                                                                                              |                   |  |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Decision Models and Analytical Techniques</b> | <b>Assessment: Assignment – Optimization, linear programming, simulation, and MCDM basics.</b>               | <b>6 Sessions</b> |  |
| Decision-making process and frameworks – Optimization models – Linear programming basics – Simulation techniques – multi-criteria decision making (MCDM) – Forecasting methods in decision-making.                                                                                                                                                                                                                                                                                                                                               |                                                  |                                                                                                              |                   |  |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>AI and Machine Learning in DSS</b>            | <b>Assessment: Assignment – Machine learning models for classification, prediction, and decision-making.</b> | <b>6 Sessions</b> |  |
| Role of AI in decision support systems – Machine learning models for decision-making – Classification and prediction models – Knowledge-based systems and expert systems – Data-driven decision models – Evaluation of intelligent DSS.                                                                                                                                                                                                                                                                                                          |                                                  |                                                                                                              |                   |  |
| <b>Module 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Applications and Case Studies of DSS</b>      | <b>Assessment: Mini Project – DSS applications in business, healthcare, finance, and smart systems.</b>      | <b>6 Sessions</b> |  |
| DSS in business analytics – DSS in healthcare and finance – Smart systems and IoT-based DSS – Case studies on decision-making systems – Ethical and privacy issues – Future trends in intelligent DSS.                                                                                                                                                                                                                                                                                                                                           |                                                  |                                                                                                              |                   |  |
| <b>List of Laboratory Tasks:</b><br><br><b>Lab 1: Introduction to Decision Support Systems</b><br><br>Understand the concept of decision support systems and their role in data-driven decision-making. Study components of DSS such as data, model, and user interface. Identify real-world applications of DSS.<br><br><b>Lab 2: Types of Decision Support Systems</b><br><br>Study different types of DSS such as data-driven, model-driven, and knowledge-driven systems. Analyze their functionalities and applications in various domains. |                                                  |                                                                                                              |                   |  |

**Lab 3: Data Management for DSS**

Perform data collection and integration from multiple sources. Understand data warehousing concepts and ETL process. Analyze data flow in decision support systems.

**Lab 4: OLAP Operations in DSS**

Perform OLAP operations such as roll-up, drill-down, slice, and dice. Analyze multidimensional data for decision-making. Understand aggregation and analysis techniques.

**Lab 5: Data Analysis for Decision Making**

Analyze datasets using Python or tools. Perform descriptive analysis and derive insights. Support decision-making using data analysis.

**Lab 6: Decision-Making Models**

Study decision-making frameworks and models. Implement basic decision models. Analyze decision outcomes.

**Lab 7: Optimization Techniques**

Apply basic optimization techniques such as linear programming. Solve decision problems using optimization methods. Analyze optimal solutions.

**Lab 8: Simulation Techniques**

Implement simulation techniques for decision-making. Model real-world scenarios. Analyze results and decision outcomes.

**Lab 9: Forecasting Methods**

Perform forecasting using statistical or machine learning methods. Predict future trends based on data. Analyze prediction accuracy.

**Lab 10: Machine Learning for DSS**

Apply machine learning models for decision-making. Implement classification and prediction techniques. Analyze model performance.

**Lab 11: Knowledge-Based Systems**

Study expert systems and knowledge-based DSS. Implement rule-based decision systems. Analyze decision logic.

**Lab 12: Dashboard Development for DSS**

Create dashboards using tools such as Power BI or Tableau. Visualize decision data. Analyze insights through dashboards.

**Lab 13: Case Study Analysis**

Analyze real-world decision-making scenarios. Apply DSS concepts to case studies. Evaluate effectiveness of decisions.

**Lab 14: Ethical Issues in DSS**

Study ethical and privacy issues in decision support systems. Analyze challenges in data-driven decision-making. Understand responsible use of data.

**Lab 15: Mini Project – Decision Support System**

Develop a complete decision support system. Perform data analysis, apply models, and generate insights. Use real-world datasets and present results.

**Targeted Applications & Tools:**

|                                   |                                         |
|-----------------------------------|-----------------------------------------|
| <b>Python (NumPy, pandas)</b>     | Data processing and analysis            |
| <b>Scikit-learn</b>               | Predictive modeling and decision-making |
| <b>Excel / Power BI / Tableau</b> | Decision dashboards and reporting       |
| <b>Optimization Tools</b>         | Basic modeling and decision analysis    |

**Skill-Building Activities through Experiential Learning:**

- **Decision Model Implementation**  
Students implement basic decision models using datasets
- **Data Analysis for Decision Making**  
Learners analyze data and derive decisions using tools
- **Dashboard Development**  
Students create decision dashboards using Power BI/Tableau
- **Case Study Analysis**  
Learners analyze real-world decision-making scenarios

**Textbooks**

T1: Efraim Turban, Ramesh Sharda, Dursun Delen, *“Decision Support and Business Intelligence Systems”*, Pearson.

T2: Vicki L. Sauter, *“Decision Support Systems for Business Intelligence”*, Wiley.

**References**

- Daniel Power, *“Decision Support Systems: Concepts and Resources”*
- Foster Provost & Tom Fawcett, *“Data Science for Business”*
- Simon Haykin, *“Neural Networks and Learning Machines”*
- Kevin P. Murphy, *“Machine Learning: A Probabilistic Perspective”*
- Christopher Bishop, *“Pattern Recognition and Machine Learning”*

**E-Resources/WebResources**

- NPTEL – Data Analytics & Decision Systems  
<https://nptel.ac.in>
- Coursera – Business Intelligence & Analytics  
<https://www.coursera.org>

- Microsoft Learn – Power BI  
<https://learn.microsoft.com>

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|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|---|----------------------|------------|---|
| Course Code:<br>CSSXXXX                                                                                                                                                                                                                                                                                                                                                                             | Course Title: Advanced Statistical Computing and Applied Inference Systems<br>Type of Course: PCC– Theory & Practical                                                                                                                                                                                                                                                                                                                                                                 | L-T-P-C | 2 | 0                    | 2          | 3 |
| VersionNo.                                                                                                                                                                                                                                                                                                                                                                                          | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |         |   |                      |            |   |
| CoursePre-requisites                                                                                                                                                                                                                                                                                                                                                                                | CSEXXXX                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |         |   |                      |            |   |
| Anti-requisites                                                                                                                                                                                                                                                                                                                                                                                     | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |         |   |                      |            |   |
| Course Description                                                                                                                                                                                                                                                                                                                                                                                  | This course trains students in advanced statistical techniques and computational inference used in real-world data-driven systems. It blends theoretical depth with hands-on implementation across estimation, hypothesis testing, regression modeling, and uncertainty quantification. The course also covers simulation-based methods and Bayesian approaches, with emphasis on applying statistical reasoning in domains such as finance, operations, and digital experimentation. |         |   |                      |            |   |
| Course Objective                                                                                                                                                                                                                                                                                                                                                                                    | To equip students with the ability to design, implement, and interpret statistical models for inference and decision-making in large-scale, complex data environments.                                                                                                                                                                                                                                                                                                                |         |   |                      |            |   |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                     | On successful completion of this course, the student shall be able to:<br><br>1. <b>Apply</b> statistical estimation and hypothesis testing in real-world scenarios<br>2. <b>Use</b> simulation techniques to approximate inference in non-analytic settings<br>3. <b>Implement</b> advanced regression and multivariate modeling<br>4. <b>Develop</b> Bayesian models for data-driven decision-making                                                                                |         |   |                      |            |   |
| Course Content:                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         |   |                      |            |   |
| Module1:                                                                                                                                                                                                                                                                                                                                                                                            | Estimation Theory and Statistical Reasoning                                                                                                                                                                                                                                                                                                                                                                                                                                           | Quiz    |   | Knowledge-based Quiz | 9 Sessions |   |
| Topics: Point estimation, confidence intervals, sampling distributions, maximum likelihood estimation (MLE), Fisher information, sufficiency<br>Tools: Python (SciPy, Statsmodels) R (base + infer) JASP for reproducible inference<br>Use Cases:<br><ul style="list-style-type: none"><li>Estimate churn probability using MLE</li><li>Construct CI for mean revenue in A/B test results</li></ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         |   |                      |            |   |
| Module 2:                                                                                                                                                                                                                                                                                                                                                                                           | Hypothesis Testing and Decision Rules                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Quiz    |   | Knowledge-based Quiz | 9 Sessions |   |

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| <b>Topics:</b> Parametric and non-parametric tests, t-tests, ANOVA, chi-square, power analysis, Type I/II errors, sequential testing<br><b>Tools:</b> Python (Pingouin, Statsmodels) R (tidyverse+car) G*Power<br><b>Use Cases:</b> <ul style="list-style-type: none"> <li>Run ANOVA on multi-region campaign effectiveness</li> <li>Perform real-time sequential testing on streaming conversion rates</li> </ul>                                                                                                                                                                      |                                                      |             |  |                      |                   |
| <b>Module 3:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Regression Models and Inference</b>               | <b>Quiz</b> |  | Knowledge-based Quiz | <b>9 Sessions</b> |
| <b>Topics:</b> Linear and generalized linear models (GLM), multicollinearity, heteroskedasticity, diagnostics, residual analysis, model comparison<br><b>Tools:</b> R (caret, glmnet), Python (Statsmodels, scikit-learn for GLM), Orange Data Mining (GUI-based)<br><b>Use Cases:</b> <ul style="list-style-type: none"> <li>Build a salary prediction model using GLM with categorical controls</li> <li>Compare linear vs ridge regression on sales forecasting</li> </ul>                                                                                                           |                                                      |             |  |                      |                   |
| <b>Module 4:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Simulation-Based and Bayesian Inference</b>       | <b>Quiz</b> |  | Knowledge-based Quiz | <b>9 Sessions</b> |
| <b>Topics:</b> Monte Carlo simulation, resampling, bootstrapping, Bayesian priors/posteriors, MAP estimation, MCMC (Metropolis-Hastings, Gibbs) <b>Tools:</b> PyMC, Stan (via R or Python), SimPy, Resample, ArviZ<br><b>Use Cases:</b> <ul style="list-style-type: none"> <li>Bootstrap confidence intervals for sample medians</li> <li>Use MCMC to estimate posterior in campaign attribution</li> </ul>                                                                                                                                                                             |                                                      |             |  |                      |                   |
| <b>Module 5:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Capstone &amp; Applied Inference Case Studies</b> | <b>Quiz</b> |  | Knowledge-based Quiz | <b>9 Sessions</b> |
| <b>Topics:</b> Real-world case studies in FinTech, eCommerce, EdTech, operations management. Emphasis on end-to-end statistical workflow from problem framing to inference and decision.<br><b>Tools:</b> Custom notebooks with integrated Jupyter/R Markdown environments, Data drawn from simulated case environments<br><b>Use Cases:</b> <ul style="list-style-type: none"> <li>Capstone: Use inference methods to assess treatment effects in an A/B/n testing setup for a mock EdTech product</li> <li>Quantify operational risk from loan defaults using Bayesian GLM</li> </ul> |                                                      |             |  |                      |                   |
| <b>Projectwork/Assignment:</b><br><br>Students will be assigned a business or public sector data challenge requiring them to frame hypotheses, run appropriate tests or simulations, apply regression or Bayesian inference, and present their results with code, plots, and interpretations. Deliverables include notebooks, statistical summaries, and an executive-style insights memo.                                                                                                                                                                                              |                                                      |             |  |                      |                   |

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| <b>TextBook</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| T1.Co-brandedZellandPaytmTextbookforAdvancedStatisticalComputingandAppliedInference Systems                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>References</b> <ul style="list-style-type: none"> <li>• T2. Casella &amp; Berger – Statistical Inference</li> <li>• T3. Kruschke – Doing Bayesian Data Analysis, Academic Press</li> <li>• T4. Efron &amp; Tibshirani – An Introduction to the Bootstrap, Chapman &amp; Hall</li> </ul>                                                                                                                                                                                                                                                                               |
| <b>Web References</b> <ul style="list-style-type: none"> <li>• <a href="https://docs.aws.amazon.com/s3/">https://docs.aws.amazon.com/s3/</a></li> <li>• <a href="https://cloud.google.com/storage/docs">https://cloud.google.com/storage/docs</a></li> <li>• <a href="https://mc-stan.org/">https://mc-stan.org/</a></li> <li>• <a href="https://cloud.google.com/storage/docs">https://cloud.google.com/storage/docs</a></li> </ul>                                                                                                                                     |
| <b>Topics relevant to SKILL DEVELOPMENT:</b><br>This course prepares students for roles that demand rigorous statistical thinking, including data scientist, research analyst, and quant analyst positions. Through extensive hands-on work with real and simulated data, learners gain the ability to run inferential analysis, justify decisions with probabilistic reasoning, and communicate uncertainty in a business-relevant context. The course also emphasizes reproducibility, model critique, and cross-functional data storytelling using modern toolchains. |

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|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|---|---|---|---|
| <b>Course Code:</b><br>CSSXXXX | <b>CourseTitle:</b> PredictiveSystemsEngineeringfor<br><b>Structured Data</b><br><b>1TypeofCourse:</b> PCC–Theory&Practical                                                                                                                                                                                                                                                                                                                                                       | <b>L-T-P-C</b> | 2 | 0 | 2 | 3 |
| <b>VersionNo.</b>              | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                |   |   |   |   |
| <b>CoursePr e-requisite s</b>  | CSEXXXX                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                |   |   |   |   |
| <b>Anti-requisites</b>         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                |   |   |   |   |
| <b>Course Descripti on</b>     | This course focuses on the design, implementation, and evaluation of predictive models built specifically for structured/tabular data systems. Students will apply statistical and algorithmic modeling techniques to business, financial, and operational datasets with a strong focus on deployment-readiness, interpretability, and reliability. Core themes include supervised learning, feature selection, model validation, regularization, and practical ensemble methods. |                |   |   |   |   |
| <b>Course Objective</b>        | To train students to develop robust predictive systems for structured data using algorithmic modeling, with a focus on evaluation, interpretability, and real-world application.                                                                                                                                                                                                                                                                                                  |                |   |   |   |   |

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| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                     | On successful completion of this course, the students shall be able to: <ol style="list-style-type: none"> <li><b>Design</b> and implement predictive models for structured datasets</li> <li><b>Apply</b> preprocessing and feature engineering tailored to tabular formats</li> <li><b>Use</b> ensemble and regularized models to improve generalization</li> <li><b>Perform</b> rigorous validation and avoid model overfitting</li> </ol> |             |  |                      |                   |
| <b>Course Content:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |  |                      |                   |
| <b>Module 1:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Predictive Modeling Framework and Data Preparation</b>                                                                                                                                                                                                                                                                                                                                                                                     | <b>Quiz</b> |  | Knowledge-based Quiz | <b>9 Sessions</b> |
| <b>Topics:</b> Types of predictive problems (classification, regression), supervised learning pipeline, data cleaning, missing value imputation, outlier handling<br><b>Tools:</b> Python (pandas, sklearn, missingno), R (tidymodels, mice), OpenRefine for structured data QA<br><b>Use Cases:</b> <ul style="list-style-type: none"> <li>Clean insurance application dataset with policy gaps</li> <li>Prepare telecom customer dataset for churn prediction</li> </ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |  |                      |                   |
| <b>Module 2:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Feature Engineering and Selection</b>                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Quiz</b> |  | Knowledge-based Quiz | <b>9 Sessions</b> |
| <b>Topics:</b> Encoding schemes, interaction features, binning, scaling, variance-based filtering, recursive feature elimination, regularized feature selection<br><b>Tools:</b> Feature-engine, scikit-learn, Boruta, R's caret and recipes<br><b>Use Cases:</b> <ul style="list-style-type: none"> <li>Create credit risk score variables from loan application history</li> <li><b>Engineer interaction terms for regional sales + time features</b></li> </ul>         |                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |  |                      |                   |
| <b>Module 3:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Algorithmic Modeling and Ensemble Techniques</b>                                                                                                                                                                                                                                                                                                                                                                                           | <b>Quiz</b> |  | Knowledge-based Quiz | <b>9 Sessions</b> |
| <b>Topics:</b> Decision trees, random forests, gradient boosting (XGBoost, LightGBM), regularized linear models (Ridge, Lasso), bagging, stacking<br><b>Tools:</b> scikit-learn, XGBoost, LightGBM, catboost, mlr3<br><b>Use Cases:</b> <ul style="list-style-type: none"> <li>Compare XGBoost and Ridge model on house price prediction</li> <li>Build and tune a fraud detection model with LightGBM</li> </ul>                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |  |                      |                   |
| <b>Module 4:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Model Validation, Diagnostics, and Interpretability</b>                                                                                                                                                                                                                                                                                                                                                                                    | <b>Quiz</b> |  | Knowledge-based      | <b>9 Sessions</b> |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |             |  | Quiz                 |                   |
| <b>Topics:</b> Train/test splits, cross-validation, ROC, AUC, confusion matrix, error metrics, SHAP, LIME, model audit frameworks<br><b>Tools:</b> SHAP, LIME, Yellowbrick, sklearn.metrics, DALEX(R)<br><b>Use Cases:</b> <ul style="list-style-type: none"> <li>Use cross-validation to avoid leakage in a churn prediction pipeline</li> <li>Interpret model risk scores using SHAP in a credit underwriting tool</li> </ul>                                                                                                          |                                              |             |  |                      |                   |
| <b>Module 5:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>Deployment, Maintenance, and Capstone</b> | <b>Quiz</b> |  | Knowledge-based Quiz | <b>9 Sessions</b> |
| <b>Topics:</b> Model persistence (Pickle, Joblib), versioning, retraining schedules, monitoring drift, performance tracking post-deployment<br><b>Tools:</b> MLflow, DVC, Evidently, BentoML, FastAPI<br><b>Use Cases:</b> <ul style="list-style-type: none"> <li>Package and deploy a predictive model for small business credit approval</li> <li>Monitor model drift in a hospital readmission predictor</li> </ul>                                                                                                                   |                                              |             |  |                      |                   |
| <b>Projectwork/Assignment:</b><br><br>Students will develop a full predictive system for a real-world tabular dataset. They will preprocess the data, engineer features, build and validate multiple models, explain model behavior using SHAP or LIME, and prepare a deployable version with appropriate documentation. The system will be graded on accuracy, reliability, and interpretability.                                                                                                                                       |                                              |             |  |                      |                   |
| <b>Text Book</b><br>T1. Co-branded Zell and Paytm Textbook for <i>Predictive Systems Engineering for Structured Data</i>                                                                                                                                                                                                                                                                                                                                                                                                                 |                                              |             |  |                      |                   |
| <b>References</b> <ul style="list-style-type: none"> <li>T2. Gareth James et al. – <i>An Introduction to Statistical Learning</i></li> <li>T3. Aurélien Géron – <i>Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow</i></li> <li>T4. Max Kuhn – <i>Feature Engineering and Selection</i>, CRC Press</li> </ul>                                                                                                                                                                                                         |                                              |             |  |                      |                   |
| <b>Web References</b> <ul style="list-style-type: none"> <li><a href="https://scikit-learn.org/">https://scikit-learn.org/</a></li> <li><a href="https://hadoop.apache.org/">https://hadoop.apache.org/</a></li> <li><a href="https://kafka.apache.org/">https://kafka.apache.org/</a></li> <li><a href="https://hive.apache.org/">https://hive.apache.org/</a></li> <li><a href="https://databricks.com/">https://databricks.com/</a></li> <li><a href="https://xgboost.readthedocs.io/">https://xgboost.readthedocs.io/</a></li> </ul> |                                              |             |  |                      |                   |
| <b>Topics relevant to SKILL DEVELOPMENT:</b><br>This course develops core competencies in predictive modeling and machine learning for structured data systems. Students gain hands-on expertise in handling business datasets, applying feature transformations, building interpretable models, and preparing them for real-world deployment. These skills directly map to roles in applied data science, credit analytics, risk modeling, and operations forecasting, where structured data is central to strategic decisions.         |                                              |             |  |                      |                   |

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| Course Code: CSSXXXX                                                                                                                                                                                                                                                                                                                        | CourseTitle:DataEngineeringPipelinesand VisualAnalytics for Strategic Communication<br>Type of Course:PCC– Theory & Practical                                                                                                                                                                                                                                                                                         |      | L-<br>T-<br>P-C | 2                    | 0 | 2          | 3 |
| VersionNo.                                                                                                                                                                                                                                                                                                                                  | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                   |      |                 |                      |   |            |   |
| CoursePre-requisites                                                                                                                                                                                                                                                                                                                        | CSEXXXX                                                                                                                                                                                                                                                                                                                                                                                                               |      |                 |                      |   |            |   |
| Anti-requisites                                                                                                                                                                                                                                                                                                                             | NIL                                                                                                                                                                                                                                                                                                                                                                                                                   |      |                 |                      |   |            |   |
| Course Description                                                                                                                                                                                                                                                                                                                          | Thiscoursefocusesonthedesigndandexecutionofdatapipelinesandthedevelopmentof meaningfulvisualanalyticsforcommunicatinginsights.Itintegratespracticalaspects of data ingestion, transformation, storage structuring, and multi-level reporting. Students will explorescalablewranglingtechniques,dashboardingframeworks,andvisualstorytelling best practices tailored for operations, management, and policy decisions. |      |                 |                      |   |            |   |
| Course Objective                                                                                                                                                                                                                                                                                                                            | To train students in building automated, auditable data engineering workflows and converting them into domain-specific visual insights for operational or strategic communication.                                                                                                                                                                                                                                    |      |                 |                      |   |            |   |
| Course Outcomes                                                                                                                                                                                                                                                                                                                             | Onsuccessfulcompletionofthiscourse,thestudentsshallbeableto:<br><br>1. <b>Build</b> structured,scalabledatapipelinesfromrawsources<br>2. <b>Apply</b> transformationandenrichmenttechniquesforbusinessreadiness<br>3. <b>Create</b> visualdashboardsandanalyticstailoredfordecision-makers<br>4. <b>Design</b> dataworkflowsforreproducibilityandcompliance                                                           |      |                 |                      |   |            |   |
| Course Content:                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                       |      |                 |                      |   |            |   |
| Module1:                                                                                                                                                                                                                                                                                                                                    | Data Acquisition and WorkflowOrchestratio<br>n                                                                                                                                                                                                                                                                                                                                                                        | Quiz |                 | Knowledge-based Quiz |   | 9 Sessions |   |
| <b>Topics:</b> ETL andELT,ingestionfromAPIs,flatfiles,databases;schedulinganddependencytracking; reproducibility and audit logs<br><b>Tools:</b><br><br>• ApacheAirflow,Prefect,Luigi,Pandas,Requests Use<br><b>Cases:</b><br><br>• BuildapipelinetopullandprocessdailyCOVID-19data<br><br>• ScheduleETLfromCRMstosystemtobusinesswarehouse |                                                                                                                                                                                                                                                                                                                                                                                                                       |      |                 |                      |   |            |   |
| Module 2:                                                                                                                                                                                                                                                                                                                                   | Transformation, Structuring, andValidation                                                                                                                                                                                                                                                                                                                                                                            | Quiz |                 | Knowledge-based Quiz |   | 9 Sessions |   |
| <b>Topics:</b> Normalization,denormalization,schemamapping,datavalidation,pipelinetesting,typecasting, outlier handling, lookup table generation<br><b>Tools:</b> dbt(DataBuildTool),GreatExpectations,SQLAlchemy,Pydantic<br><b>UseCases:</b>                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                       |      |                 |                      |   |            |   |

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|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|-------------|----------------------|-------------------|
| <ul style="list-style-type: none"> <li>• Clean transaction records from a lending app</li> <li>• Validate input types for pricing feeds in a marketplace</li> </ul>                                                                                                                                                                                                                                                                                                                              |                                                           |             |                      |                   |
| <b>Module 3:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Analytical Aggregations and Storage</b>                | <b>Quiz</b> | Knowledge-based Quiz | <b>9 Sessions</b> |
| <b>Topics:</b> OLAP vs OLTP structuring, window functions, cohort creation, time series aggregation, handling slowly changing dimensions (SCD)<br><b>Tools:</b> SQL (PostgreSQL, BigQuery), ClickHouse, DuckDB, Polars<br><b>Use Cases:</b> <ul style="list-style-type: none"> <li>• Create rolling weekly dashboards for user retention</li> <li>• Build cohort retention summaries for a streaming service</li> </ul>                                                                          |                                                           |             |                      |                   |
| <b>Module 4:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Visual Analytics and Executive Dashboards</b>          | <b>Quiz</b> | Knowledge-based Quiz | <b>9 Sessions</b> |
| <b>Topics:</b> Graph types and use cases, user-focused design, interactivity, filtering, dashboard KPIs, color and typography for clarity<br><b>Tools:</b> PowerBI, Tableau, Plotly Dash, Metabase, Streamlit<br><b>Use Cases:</b> <ul style="list-style-type: none"> <li>• Build a real-time dashboard for operations support in logistics</li> <li>• Create investor-oriented visualizations for business KPIs</li> </ul>                                                                      |                                                           |             |                      |                   |
| <b>Module 5:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Capstone - Reporting Pipelines for Business Impact</b> | <b>Quiz</b> | Knowledge-based Quiz | <b>9 Sessions</b> |
| <b>Topics:</b> Visual storytelling, tailoring reports for stakeholders, automation of reporting cycles, error-handling in pipelines, documentation best practices<br><b>Tools:</b> Jupyter + nbconvert, Apache Superset, Google Data Studio, Notion for report delivery<br><b>Use Cases:</b> <ul style="list-style-type: none"> <li>• Automate weekly report on customer segmentation for a D2C brand</li> <li>• Convert analytical notebooks into stylized, sharable insight reports</li> </ul> |                                                           |             |                      |                   |
| <b>Projectwork/Assignment:</b><br><br>Students will design a complete data reporting pipeline for a business or institutional use case. It must ingest raw or semi-structured data, apply transformations, load it into a queryable store, and present key insights through a structured dashboard or visual report. Deliverables include the data pipeline code, dashboard link or screenshots, and an insight memo for a specific stakeholder group.                                           |                                                           |             |                      |                   |
| <b>Text Book</b><br>T1. Co-branded Zell and Paytm Textbook for <i>Data Engineering Pipelines and Visual Analytics for Strategic Communication</i>                                                                                                                                                                                                                                                                                                                                                |                                                           |             |                      |                   |

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| <b>References</b> <ul style="list-style-type: none"> <li>• T2.NoahGift–PracticalDataEngineering,Addison-Wesley</li> <li>• T3.ColeNussbaumerKnaflc–StorytellingwithData,Wiley</li> <li>• T4.ValliappaLakshmanan–DataPipelinesPocket Reference,O’Reilly</li> </ul>                                                                                                                                                                                                                                                                                                      |
| <b>Web References</b> <ul style="list-style-type: none"> <li>• <a href="https://docs.getdbt.com/">https://docs.getdbt.com/</a></li> <li>• <a href="https://pytorch.org/">https://pytorch.org/</a></li> <li>• <a href="https://keras.io/">https://keras.io/</a></li> <li>• <a href="https://huggingface.co/">https://huggingface.co/</a></li> <li>• <a href="https://paperswithcode.com/">https://paperswithcode.com/</a></li> </ul>                                                                                                                                   |
| <b>Topics relevant to SKILL DEVELOPMENT:</b><br>This course builds foundational skills in end-to-end data engineering and analytics reporting, focused on creating automated, trustworthy insight pipelines. Students gain experience working with real-world ETL tools, managing schema transformations, and structuring visual reports that drive action. These capabilities map directly to roles in data analytics engineering, business intelligence, and stakeholder-oriented reporting teams across sectors like finance, healthcare, and consumer technology. |

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| Course Code:<br>CSSXXXX | CourseTitle:DistributedDataSystemsandHigh-ThroughputAnalytics<br>TypeofCourse:PCC–Theory&Practical                                                                                                                                                                                                                                                                                                                                                                   | L-T-P-C | 2 | 0               | 2          | 3 |
| VersionNo.              | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         |   |                 |            |   |
| CoursePre-requisites    | CSEXxxx                                                                                                                                                                                                                                                                                                                                                                                                                                                              |         |   |                 |            |   |
| Anti-requisites         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         |   |                 |            |   |
| Course Description      | This course covers the architecture and engineering of large-scale, distributed data systems used for real-time and batch analytics. Students will work with modern data processing engines, cloud-native storage layers, and columnar formats to design scalable data solutions. Emphasis is placed on speed, fault tolerance, partitioning, parallel execution, and the ability to serve multiple analytical workloads with guaranteed reliability and efficiency. |         |   |                 |            |   |
| Course Objective        | Toenablestudentstodesign,build,andoptimizescalabledatasystemsthat support high-throughput analytics across distributed computing platforms.                                                                                                                                                                                                                                                                                                                          |         |   |                 |            |   |
| Course Outcomes         | Onsuccessfulcompletionofthiscourse,thestudentsshallbeableto: <ol style="list-style-type: none"> <li>1. <b>Engineer</b>distributeddatapipelinesusingmodernprocessingframeworks</li> <li>2. <b>Choose</b>appropriatestorageandpartitioningstrategiesforspeedandscale</li> <li>3. <b>Optimize</b>queryexecutionacrosslargedatasets</li> <li>4. <b>Implement</b>fault-tolerantreal-timeandbatchpipelines</li> </ol>                                                      |         |   |                 |            |   |
| Course Content:         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |         |   |                 |            |   |
| Module1:                | DistributedStorageand ProcessingFoundations                                                                                                                                                                                                                                                                                                                                                                                                                          | Quiz    |   | Knowledge-based | 9 Sessions |   |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                  |             |  | Quiz                        |                       |
| <b>Topics:</b> Distributedfilesystems,datalocality,partitioningstrategies,columnarformats(Parquet/ORC), object storage (S3, GCS)<br><b>Tools:</b> HDFS,AmazonS3,GoogleCloudStorage,Parquet,Avro,DuckDB<br><b>UseCases:</b> <ul style="list-style-type: none"> <li>• StoreandcompressretailtransactiondatausingParquet</li> <li>• Partitionride-sharingdatabygeohashfordistributedquerying</li> </ul>                                |                                                  |             |  |                             |                       |
| <b>Module 2:</b>                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>BatchProcessingatScale</b>                    | <b>Quiz</b> |  | Knowledge<br>-based<br>Quiz | <b>9<br/>Sessions</b> |
| <b>Topics:</b> MapReduce patterns, DAG scheduling, data shuffling, join optimization, job retries and fault recovery<br><b>Tools:</b> ApacheSpark,Databricks,GoogleDataflow<br><b>UseCases:</b> <ul style="list-style-type: none"> <li>• Performdistributedjoinsacrossproductlogsandusermetadata</li> <li>• <b>Run hourly batch processing of video engagement metrics</b></li> </ul>                                               |                                                  |             |  |                             |                       |
| <b>Module 3:</b>                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Real-TimeandStream<br/>Processing</b>         | <b>Quiz</b> |  | Knowledge<br>-based<br>Quiz | <b>9<br/>Sessions</b> |
| <b>Topics:</b> Streamingestion,eventtimevsprocessingtime>windowedaggregations,watermarking, stateful processing, at-least-once vs exactly-once guarantees<br><b>Tools:</b> ApacheKafka,ApacheFlink,SparkStructuredStreaming,KafkaConnect<br><b>UseCases:</b> <ul style="list-style-type: none"> <li>• Ingestandprocessfinancialtickdatainnearrealtime</li> <li>• Implementsession-basedwindowingforonlineactivitystreams</li> </ul> |                                                  |             |  |                             |                       |
| <b>Module 4:</b>                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>QueryEnginesandAnalytica<br/>l Interfaces</b> | <b>Quiz</b> |  | Knowledge<br>-based<br>Quiz | <b>9<br/>Sessions</b> |
| <b>Topics:</b> SQL-on-big-data,cost-basedoptimization,distributedjoins,caching,federation,andlakehouse architecture<br><b>Tools:</b> Presto/Trino,BigQuery,Dremio,Starburst,DeltaLake<br><b>UseCases:</b> <ul style="list-style-type: none"> <li>• QueryJSONlogsacrossmultiplecloudbucketsusingPresto</li> <li>• JoinS3-basedtableswithJDBCsourcesusingfederatedqueries</li> </ul>                                                  |                                                  |             |  |                             |                       |

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| <b>Module 5:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Capstone–PipelineDesign, Benchmarking, and Observability</b> | <b>Quiz</b> |  | Knowledge-based Quiz | <b>9 Sessions</b> |
| <b>Topics:</b> Performancemonitoring,datalineage,logging&metrics,joborchestration,alerting,scalability benchmarking<br><b>Tools:</b> Airflow,Prometheus+Grafana,GreatExpectations,OpenLineage<br><b>UseCases:</b> <ul style="list-style-type: none"> <li>• <b>Benchmarkpipelinethroughputacrossstoragetiers</b></li> <li>• <b>Setalertsforlatedataarrivalorjobfailures</b></li> </ul>                                                                                                                                     |                                                                 |             |  |                      |                   |
| <b>Projectwork/Assignment:</b><br>Studentswilldesignaproducton-readyanalyticspipelineforadomaindataset(e.g.,eCommerce,IoT telemetry, or digital banking). It should demonstrate scalable ingestion, transformation, storage, and query capability over large volumes. Deliverables include architecture diagrams, code artifacts, benchmark metrics, and a report documenting design decisions.                                                                                                                           |                                                                 |             |  |                      |                   |
| <b>TextBook</b><br>T1.Co-brandedZellandPaytmTextbookfor <i>DistributedDataSystemsandHigh-ThroughputAnalytics</i>                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                 |             |  |                      |                   |
| <b>References</b> <ul style="list-style-type: none"> <li>• <i>T2.JeffCarpenter–FundamentalsofDataEngineering,O'Reilly</i></li> <li>• <i>T3.MateiZahariaetal.–Spark:TheDefinitiveGuide</i></li> <li>• <i>T4.HoldenKarau–HighPerformanceSpark</i></li> </ul>                                                                                                                                                                                                                                                                |                                                                 |             |  |                      |                   |
| <b>Web References</b> <ul style="list-style-type: none"> <li>• <a href="https://flink.apache.org/">https://flink.apache.org/</a></li> <li>• <a href="https://matplotlib.org/">https://matplotlib.org/</a></li> <li>• <a href="https://public.tableau.com/">https://public.tableau.com/</a></li> <li>• <a href="https://powerbi.microsoft.com/">https://powerbi.microsoft.com/</a></li> <li>• <a href="https://towardsdatascience.com/">https://towardsdatascience.com/</a></li> </ul>                                     |                                                                 |             |  |                      |                   |
| <b>Topics relevant to SKILL DEVELOPMENT:</b><br>This course develops the ability to build high-scale data systems for both real-time and batch analytics. Students learn to choose the right tools and storage formats, optimize workloads, and troubleshoot performance issues in distributed environments. These competencies directly support roles in data engineering, cloud analytics, and platform architecture for large-scale systems in industries like finance, healthcare, logistics, and consumer platforms. |                                                                 |             |  |                      |                   |

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| <b>Course Code:</b><br>CSS3502 | <b>CourseTitle:</b> MultidimensionalDataModelingan<br><b>d Representation Learning</b><br><b>TypeofCourse:</b> PEC–TheoryGLabIntegrated | <b>L-T-P-C</b> | 2 | 0 | 2 | 3 |
| <b>VersionNo.</b>              | 1.0                                                                                                                                     |                |   |   |   |   |
| <b>CoursePr e-requisite s</b>  | CSEXXXX                                                                                                                                 |                |   |   |   |   |

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| <b>Anti-requisites</b>                                                                                                                                                                                                                                                                                                                                                                                                               | <b>NIL</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |  |                          |                    |
| <b>Course Description</b>                                                                                                                                                                                                                                                                                                                                                                                                            | This course focuses on modeling and learning from high-dimensional, structured, and unstructured data using neural architectures and representation learning techniques. It includes architectural considerations for tabular, text, image, and mixed-format inputs. Topics cover feature embeddings, deep multilayer models, convolutional architectures, autoencoders, and embedding spaces for downstream tasks such as classification, ranking, and retrieval.                             |                   |  |                          |                    |
| <b>Course Objective</b>                                                                                                                                                                                                                                                                                                                                                                                                              | To develop practical competence in designing and training deep models that extract useful representations from high-dimensional data for real-world predictive and descriptive tasks.                                                                                                                                                                                                                                                                                                          |                   |  |                          |                    |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                               | Upon successful completion of the course, students will be able to: <ol style="list-style-type: none"> <li>1. <b>Model</b> structured and unstructured data using neural networks</li> <li>2. <b>Extract</b> and interpret data representations using dimensionality-reduction and embeddings</li> <li>3. <b>Design</b> architectures suited for tabular, text, and visual input types</li> <li>4. <b>Train</b>, validate, and monitor deep models for generalization and stability</li> </ol> |                   |  |                          |                    |
| <b>Course Content:</b>                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |  |                          |                    |
| <b>Module 1:</b>                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Deep Feedforward Models for Tabular and Mixed Data</b>                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Quiz</b>       |  | Knowledge based Quiz     | <b>9 Sessions</b>  |
| <b>Topics:</b> Multilayer perceptrons, hidden layer tuning, activation design, dropout, batch normalization, categorical embeddings<br><b>Tools:</b> PyTorch, TensorFlow/Keras, FastAI Tabular, Weights & Biases<br><b>Use Cases:</b> <ul style="list-style-type: none"> <li>• Learn feature interactions in a loan default prediction task</li> <li>• Compare learned embeddings to one-hot encodings in retail datasets</li> </ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |  |                          |                    |
| <b>Module 2:</b>                                                                                                                                                                                                                                                                                                                                                                                                                     | Representation Learning for Text and Sequences                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Quiz</b>       |  | Comprehension based Quiz | <b>9 Sessions</b>  |
| <b>Topics:</b> Word embeddings (Word2Vec, GloVe), sequence modeling with RNN/LSTM, attention, padding/masking strategies<br><b>Tools:</b> spaCy, HuggingFace Transformers, Gensim, TorchText<br><b>Use Cases:</b> <ul style="list-style-type: none"> <li>• Build customer review embeddings for sentiment clustering</li> <li>• Use LSTM for event log sequence classification</li> </ul>                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |  |                          |                    |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Convolutional Architectures and Dimensionality Reduction</b>                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Assignment</b> |  | Batch-wise Assignments   | <b>09 Sessions</b> |

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| <b>Topics:</b> CNNsforimage/structuredinput,pooling,receptivefields,autoencoders, latent space compression, t-SNE, PCA, UMAP<br><b>Tools</b> OpenCV+PyTorch,TensorBoard,scikit-learn,UMAP-learn<br><b>UseCases:</b> <ul style="list-style-type: none"> <li>• Trainconvolutionalmodelonbusinessdocumentimageclassification</li> <li>• Buildautoencoderforanomalydetectioninsensordata</li> </ul>                                                             |                                                                 |                             |                                        |                    |
| <b>Module 4:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>ModelTuning, Regularization,and Deployment</b>               | Assignmentand Presentation  | Batch-wise Assignmentand Presentations | <b>09 Sessions</b> |
| <b>Topics:</b> Overfittingmitigation,earlystopping,weightdecay,modelcheckpointing, inferenceoptimization<br><b>Tools:</b> Optuna,KerasTuner,ONNX,TorchScript,Flask/Streamlitfordeployment<br><b>UseCases:</b> <ul style="list-style-type: none"> <li>• DeploytabulardeeplearningmodelvialightweightAPI</li> <li>• Auto-tunehyperparametersforchurnpredictiontask</li> </ul>                                                                                 |                                                                 |                             |                                        |                    |
| <b>Module 5:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Capstone – Representational Systems in Industry Contexts</b> | Assignment and Presentation | Batch-wise Assignment and Presentation | <b>9 Sessions</b>  |
| <b>Topics:</b> End-to-endmodelingworkflowsonrealdata;explainability(SHAPforNN),domain-aligned representations, embedding visualization and export<br><b>Tools:</b> Captum,Lucid(featurevisualization),Netron,TensorBoardProjector<br><b>UseCases:</b> <ul style="list-style-type: none"> <li>• Buildfullpipeline forcustomerbehaviormodelingwithembeddings</li> <li>• Applydimensionalityreductionandclustervisualizationforpatientdiagnosisdata</li> </ul> |                                                                 |                             |                                        |                    |
| <b>Projectwork/Assignment:</b><br>Students will build an end-to-end modeling pipeline that learns data representations and uses them for a downstream task (classification, regression, anomaly detection, etc.). Deliverables include the trained model, visualization of learned representations, deployment-ready notebook, and a written summary of architecture design decisions.                                                                      |                                                                 |                             |                                        |                    |
| <b>Text Book</b><br><b>T1. Co-branded Zell and Paytm Textbook for Multidimensional Data Modeling and Representation Learning</b>                                                                                                                                                                                                                                                                                                                            |                                                                 |                             |                                        |                    |

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| <b>Reference</b><br>T2. Ian Goodfellow et al. – Deep Learning, MIT Press<br>T3. Sebastian Raschka – Machine Learning with PyTorch and Scikit-Learn<br>T4. Francois Chollet – Deep Learning with Python<br><b>Web References</b><br><a href="https://www.tensorflow.org/">https://www.tensorflow.org/</a><br><a href="https://umap-learn.readthedocs.io/en/latest/">https://umap-learn.readthedocs.io/en/latest/</a>                                                                                                             |
| <b>Topics relevant to SKILL DEVELOPMENT:</b> This course prepares students to build neural architectures that learn from complex, multidimensional data. They gain practical exposure to tabular, textual, and visual modeling pipelines, and acquire skills in dimensionality reduction, embedding optimization, and deployment of trained models. These skills are directly applicable to roles in data science, AI product engineering, personalization systems, and anomaly detection in business or operational workflows. |

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| <b>Course Code:</b><br>CSS3502 | <b>Course Title:</b> OperationalAnalytics and Computational Optimization Techniques?<br><b>Type of Course:</b> PEC–TheoryGLabIntegrated                                                                                                                                                                                                                                                                                                                          | <b>L-T-P-C</b> | 2 | 0                    | 2                 | 3 |
| <b>Version No.</b>             | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                |   |                      |                   |   |
| <b>Course Prerequisites</b>    | CSEXXXX                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                |   |                      |                   |   |
| <b>Anti-requisites</b>         | NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                |   |                      |                   |   |
| <b>Course Description</b>      | This course focuses on the application of optimization and decision-making frameworks in real-world operational contexts such as supply chain management, workforce scheduling, transportation, and finance. Students learn to formulate problems mathematically, implement computational optimization algorithms, and build analytic solutions that support strategic and tactical decisions under constraints.                                                 |                |   |                      |                   |   |
| <b>Course Objective</b>        | To train students to design and implement analytics-driven optimization models that enhance operational efficiency, resource utilization, and planning accuracy across industries.                                                                                                                                                                                                                                                                               |                |   |                      |                   |   |
| <b>Course Outcomes</b>         | By the end of this course, students will be able to: <ol style="list-style-type: none"> <li>1. <b>Translate</b> real-world constraints into solvable optimization models</li> <li>2. <b>Apply</b> mathematical programming to multi-variable operational problems</li> <li>3. <b>Use</b> solvers and simulation tools to derive and validate solutions</li> <li>4. <b>Build</b> reproducible analytic systems for logistics, planning, and scheduling</li> </ol> |                |   |                      |                   |   |
| <b>Course Content:</b>         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                |   |                      |                   |   |
| <b>Module 1:</b>               | <b>Computational Strategies for Linear and Integer Optimization</b>                                                                                                                                                                                                                                                                                                                                                                                              | <b>Quiz</b>    |   | Knowledge based Quiz | <b>9 Sessions</b> |   |

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| <b>Topics:</b> Problem formulation, linear programming (LP), integer programming (IP), duality, feasibility, boundedness, sensitivity analysis<br><b>Tools:</b> PuLP, SciPy.optimize, Google OR-Tools, R's lpSolve<br><b>Use Cases:</b> <ul style="list-style-type: none"> <li>• Optimize vendor selection with capacity and cost constraints</li> <li>• Allocate marketing budget across regions to maximize ROI</li> </ul> |                                                  |                                    |  |                                         |                    |
| <b>Module 2:</b>                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Resource Allocation and Scheduling Models</b> | <b>Quiz</b>                        |  | Comprehensive based Quiz                | <b>09 Sessions</b> |
| <b>Topics:</b> Knapsack, assignment, transportation, and job-shop scheduling problems; penalty costs, priorities, and time windows<br><b>Tools:</b> Gurobi, CPLEX, MiniZinc, Pyomo<br><b>Use Cases:</b> <ul style="list-style-type: none"> <li>• Schedule a delivery fleet for urban last-mile logistics</li> <li>• Assign workers to shifts minimizing total overtime</li> </ul>                                            |                                                  |                                    |  |                                         |                    |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Network and Flow Optimization</b>             | <b>Assignment</b>                  |  | Batch-wise Assignments                  | <b>09 Sessions</b> |
| <b>Topics:</b> Network flows, max-flow/min-cut, shortest path, multi-commodity flow, vehicle routing, bottleneck analysis<br><b>Tools:</b> NetworkX, Google OR-Tools Routing, Graph-tool<br><b>Use Cases:</b> <ul style="list-style-type: none"> <li>• Route optimization for supply chain hubs</li> <li>• Analyze flow saturation in telecom and energy networks</li> </ul>                                                 |                                                  |                                    |  |                                         |                    |
| <b>Module 4:</b>                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Simulation and Metaheuristics</b>             | <b>Assignment and Presentation</b> |  | Batch-wise Assignment and Presentations | <b>09 Sessions</b> |
| <b>Topics:</b> Monte Carlo simulation, stochastic optimization, genetic algorithms, simulated annealing, tabu search, constraint relaxation<br><b>Tools:</b> SimPy, DEAP, Optuna, AnyLogic<br><b>Use Cases:</b> <ul style="list-style-type: none"> <li>• Run simulation to test various demand planning scenarios</li> <li>• Apply evolutionary algorithms to product bundling problems</li> </ul>                           |                                                  |                                    |  |                                         |                    |

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| <b>Module 5:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Capstone–Real-World Decision Optimization</b> | Assignment and Presentation | Batch-wise Assignment and Presentation | <b>09 Sessions</b> |
| <p><b>Topics:</b> Integrated optimization and analytics workflow, solution reporting, model validation, stakeholder alignment</p> <p><b>Tools:</b> PowerBI/Tableau for impact dashboards, Python notebooks, Dash</p> <p><b>Use Cases:</b></p> <ul style="list-style-type: none"> <li>• <b>Capstone:</b> Build an end-to-end solution to optimize operations in a mock airline, retailer, or hospital</li> <li>• Integrates solver outputs into a dashboard for decision-makers</li> </ul>                                                                                                      |                                                  |                             |                                        |                    |
| <p><b>Projectwork/Assignment:</b></p> <p>Students will build an optimization system for a chosen operational domain (e.g., logistics, inventory, energy, workforce planning). The solution must include model formulation, computational implementation, scenario testing, and stakeholder-friendly reporting. Deliverables include a coded model, validation outputs, and an executive presentation of impact.</p>                                                                                                                                                                            |                                                  |                             |                                        |                    |
| <p><b>Text Book - T1.</b> Co-branded Zell and Paytm Textbook for Operational Analytics and Computational Optimization Techniques</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                  |                             |                                        |                    |
| <p><b>Reference</b></p> <p>T2. Winston &amp; Goldberg – Operations Research: Applications and Algorithms T3. Paul A. Jensen – Introduction to Optimization Techniques</p> <p>T4. Ravindra K. Ahuja – Network Flows: Theory, Algorithms, and Applications</p> <p><b>Web References</b></p> <p><a href="https://www.gurobi.com/">https://www.gurobi.com/</a><a href="https://networkx.org/">https://networkx.org/</a></p>                                                                                                                                                                        |                                                  |                             |                                        |                    |
| <p><b>Topics relevant to SKILL DEVELOPMENT:</b> This course prepares students for high-impact roles in operations research, supply chain analytics, logistics optimization, and quantitative strategy. Through end-to-end modeling and decision-support simulations, learners gain the ability to build scalable, interpretable optimization systems that respond to changing operational constraints. Students graduate with a portfolio-ready project and the technical proficiency to contribute to planning, resourcing, and performance optimization in complex business environments</p> |                                                  |                             |                                        |                    |