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**

**2026-2028**

**MASTER OF TECHNOLOGY (M.Tech.) in**

**Data Science**

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

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## 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 Presidency School of Computer Science and Engineering, committed to developing globally competent engineers, dedicated to developing cutting-edge technology to enhance the quality of life.

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

- Cultivate a practice-driven environment with computing-based pedagogy, integrating theory and practice.
- Attract and nurture world-class faculty to excel in teaching and research in the realm of computing sciences.
- Establish state-of-the-art computing facilities for effective teaching and learning experiences.
- Promote interdisciplinary studies to nurture talent 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 M.Tech degree.

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

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 Master of Technology Degree Program Regulations and Curriculum 2026-2028.
b. These Regulations are subject to, and pursuant to the Academic Regulations.
c. These Regulations shall be applicable to the ongoing Master of Technology Degree Programs of the 2026-2028 batch, and to all other Master of Technology Degree Programs which may be introduced in future.
d. These Regulations shall supersede all the earlier Master of Technology Degree Program Regulations and Curriculum, along with all the amendments thereto.
e. These Regulations shall come into force from the Academic Year 2026-2027.

## 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 M.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 Master of Technology Degree Program Regulations and Curriculum, 2026-2028;*

ff. *"Program" means the Masterr of Technology (M.Tech.) Degree Program;*

gg. *"PSCS" means the Presidency School of 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;*

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 Master of Technology Degree Program Regulations and Curriculum 2026-2028 are subject to, and, pursuant to the Academic Regulations. These Program Regulations shall be applicable to the following ongoing Master of Technology (M.Tech.) Degree Programs of 2026-2028 offered by the Presidency School of Engineering (PSOE):

1. Master of Technology in Computer Science and Engineering Specialization in Artificial Intelligence.M.Tech. (AIE)
2. Master of Technology in Computer Science and Engineering Specialization in Data Science.M.Tech. (DSC)

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 considerations

## 6. Minimum and Maximum Duration

6.1 Master of Technology Degree Program is a Two-Year, Full-Time Semester based program. The minimum duration of the M.Tech. Program is four (02) years and each year comprises of two academic Semesters (Odd and Even Semesters) and hence the duration of the M.Tech. program is four (04) 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:

PEO 01: To prepare graduates who will be successful professionals in industry, government, academia, research, entrepreneurial pursuit and consulting firms.

PEO 02: To prepare graduates who will contribute to society as broadly educated, expressive, ethical and responsible citizens with proven expertise.

PEO 03: To prepare graduates who will achieve peer recognition as individuals or in a team through demonstration of good analytical, research, design and implementation skills.

PEO 04: To prepare graduates who will thrive to pursue life-long reflective learning to fulfil their goals.

## 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:

PO1:An ability to analysis, manage and supervise engineering systems and processes with the aid of appropriate advanced tools.

PO2:An ability to design a system and process within constraints of health, safety, security, economics, manufacturability to meet desired needs.

PO3:An ability to carry out research in the respective discipline and publish the findings.

PO4:An ability to effectively communicate and transfer the knowledge/ skill to stakeholders.

PO5:An ability to realize the impact of engineering solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.

### 8.2 Program Specific Outcomes(PSOs):

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

**PSO 1:**

Apply foundational and advanced data science methodologies to analyze, model, and extract meaningful insights from complex and large-scale datasets for solving real-world problems across multiple domains.

**PSO 2:**

Demonstrate proficiency in designing and deploying scalable, data-driven systems using appropriate tools, technologies, and platforms to support informed decision-making and innovation.

**PSO 3:**

Exhibit ethical and responsible data handling practices while ensuring data privacy, transparency, and fairness in analytics and machine learning applications for societal and industrial impact.

## 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 M.Tech. Program is listed in the following Sub-Clauses:

- Have a Bachelor's degree in engineering (B.E./B.Tech) from a recognized university.
- Have a minimum aggregate of 50% in your Bachelor's degree.

- Have a minimum aggregate of 45% in your Bachelor's degree if you belong to a reserved category.
- Have to submit score card from any state or central entrance exam or the Presidency University admission qualifying exam

## 10. 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)

**10.1** 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.

**10.2** 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.

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

**10.4** 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)

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 shall 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.

**10.5 Assessment Components and Weightage**

**Table 1: Assessment Components and Weightage for different category of Courses**

| Nature of Course and Structure | Evaluation Component | Weightage |
|---|---|---|
| **Lecture-based Course**<br>L component in the L-T-P Structure is predominant (more than 1)<br>(Examples: 3-0-0; 3-0-2; 2-1-0; 2-0-2, 2-0-4 etc.) | Continuous Assessments | 50% |
| | End Term Examination | 50% |
| **Lab/Practice-based Course**<br>P component in the L-T-P Structure is predominant<br>(Examples: 0-0-4; 1-0-4; 1-0-2; etc.) | Continuous Assessments | 50% |
| | End Term Examination | 50% |

| | |
|---|---|
| **Skill based Courses** like Industry Internship, Capstone project, Research Dissertation, Integrative Studio, Interdisciplinary Project, Summer / Short Internship, Social Engagement / Field Projects, Portfolio, and such similar Non-Teaching Credit Courses, where the pedagogy does not lend itself to a typical L-T-P structure | Guidelines for the assessment components for the various types of Courses, with recommended weightages, shall be specified in the concerned Program Regulations and Curriculum / Course Plans, as applicable. |

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–P–C) [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.

### 10.6 Minimum Performance Criteria:

#### 10.6.1 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.

#### 10.6.2 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.

**10.6.3** 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-clause 8.9.1 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.

## 11 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:

**11.1** 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.

**11.2** 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.

**11.3** 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:

**11.3.1** A student may complete SWAYAM/NPTEL/other approved MOOCs as mentioned in Clause11.3 (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.

**11.3.2** SWAYAM/NPTEL/ other approved MOOCs as mentioned in Clause 11.3 (as per academic regulations) shall be approved by the concerned Board of Studies and placed (as Annexures) in the concerned PRC.

**11.3.3** 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.

**11.3.4** 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.

**11.3.5** A student shall request for transfer of credits only from such approved Courses as mentioned in Sub-Clause 11.3.2 above.

**11.3.6** 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.

**11.3.7** 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 forwarded to the COE for processing of results of the concerned Academic Term.

**11.3.8** 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 summarised in Table shown below. The Grade will be calculated from the marks received by the Absolute Grading Table 8.11 in the academic regulations.

**Table 2: Durations and Credit Equivalence for Transfer of Credits from SWAYAM-NPTEL/ other approved MOOC Courses**

| Sl. No. | Course Duration | Credit Equivalence |
|---|---|---|
| 1 | 4 Weeks | 1 Credit |
| 2 | 8 Weeks | 2 Credits |
| 3 | 12 Weeks | 3 Credits |

**11.3.9** 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 forthe award ofthe concernedDegree.

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

**11.4** Themaximumnumberofcreditsthatcanbetransferredbyastudentshallbelimitedtoforty percent (40%) of the mandatory minimum credit requirements specified by the concerned Program Regulations and Curriculum forthe award ofthe concernedDegree. However, the grades obtained in the Courses transferred from other Institutions/MOOCs, as mentioned in this Section (11.0), shall not be included in the calculation of the CGPA.

## PART B: PROGRAM STRUCTURE

### 12. 0 Structure / Component with Credit Requirements Course Baskets & Minimum Basket wise Credit Requirements

The M.Tech. CSE Specialization in (Data Science) Program Structure (2026-2028) totalling 68credits. Table 3 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.

**Table 3: Summary of mandatory courses and minimum credit contribution from various baskets**

| S.No | Baskets | Credit Contribution |
|---|---|---|
| 1 | SCHOOLCORE | 32 |
| 2 | PROGRAMCORE | 15 |
| 3 | DISCIPLINEELECTIVE | 15 |
| 4 | OPENELECTIVE | 06 |
| | **TOTALCREDITS** | **Min. 68** |

In the entire Program, the practical and skill based course component contribute to an extent of approximately 61% out of the total credits of 68 for M.Tech. (Product Design and Development) program of twoyears' duration.

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

As per the AICTE guidelines, a minimum of 68 credits is required for the award of a M.Tech. degree.

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

14.1 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**.**

14.2 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 5.0 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 19.2.1a 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**

**15. 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 |

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

**Table 3.1 : List of School Core (SC)**

| S.No | Course Code | Course Name | L | T | P | C | Contact Hours | Type of Skills | Pre requisite |
|---|---|---|---|---|---|---|---|---|---|
| 1 | MAT6001 | Advanced Engineering Mathematics | 3 | 0 | 0 | 3 | 3 | S | - |
| 2 | ENG5001 | English for Employability | 2 | 1 | 0 | 3 | 3 | S | - |
| 3 | SEM5001 | Seminar – I | - | - | - | 1 | | S/EM | - |
| 4 | SEM5002 | Seminar – II | - | - | - | 1 | | S/EM | - |
| 5 | PIP6001 | Dissertation/ Internship – I | - | - | - | 10 | | S/EM | - |
| 6 | PIP6002 | Dissertation/ Internship – II | - | - | - | 14 | | S/EM | - |
| | | **Total No. of Credits** | | | | **32** | | | |

**Table 3.2 : List of Programme Core Courses (PC)**

| S.No | Course Code | Course Name | L | T | P | C | Contact Hours | Type of Skills | Pre requisite |
|---|---|---|---|---|---|---|---|---|---|
| 1 | DSC4000 | Statistics for Data Science | 3 | 0 | 0 | 3 | 3 | S | - |
| 2 | DSC4001 | Programming in Data Science | 2 | 0 | 2 | 3 | 4 | S | - |
| 3 | DSC4002 | Data Analytics and Visualization | 2 | 0 | 2 | 3 | 4 | S | - |
| 4 | DSC4003 | Data Mining and Predictive Analytics | 2 | 0 | 2 | 3 | 4 | S | - |
| 5 | DSC4004 | Big Data Analytics Tools and | 2 | 0 | 2 | 3 | | S | - |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Techniques | | | | | 4 | | |
| | | | | | **Total No. of Credits** | **15** | | | |

## 16. 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 M.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.

### *16.1 Internship*

A student may undergo an Internship for a period of 12-14 weeks in an industry / company or academic / research institution during 3rd and 4thSemesters, subject to the following conditions:

**16.1.1** The Internship shall be in conducted in accordance with the Internship Policy prescribed by the University from time to time.

**16.1.2** 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 Internship to a student;

**16.1.3** The number of Internships available for the concerned Academic Term. Further, the available number of internships 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 Internship, as stated in Sub-Clause 16.1.2 above.

**16.1.4** A student may opt for Internship 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 Internship on her / his own. Provided further, that the Industry / Company or academic / research institution offering such Internship confirms to the University that the Internship shall be conducted in accordance with the Program Regulations and Internship Policy of the University.

**16.1.5** A student selected for an Internship in an industry / company or academic / research

institution shall adhere to all the rules and guidelines prescribed in the Internship Policy of the University.

### *16.2 Project Work*

A student may opt to do a Project Work for a period of 12-15 weeks in an Industry / Company or academic / research institution or the University Department(s) as an equivalence of Internship during the 3rd and 4thSemester as applicable, subject to the following conditions:

***16.2.1*** The Project Work shall be approved by the concerned HOD and be carried out under the guidance of a faculty member.

***16.2.2*** 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 16.2.1). 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.

### *16.3 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 4th Semester as applicable, subject to the following conditions:

**16.3.1** The Capstone Project shall be in conducted in accordance with the Capstone Project Policy prescribed by the University from time to time.

**16.3.2** 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;

**16.3.3** 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 16.3.2 above.

**16.3.4** 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 Capstone project Policy of the University.

**16.3.5** 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.

### *16.4 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:

***16.4.1*** 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 18.4.1). 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.

**17. List of Discipline Elective Courses:**

**Table 3.3 DISCIPLINE ELECTIVE - Minimum of 15 Credits to be earned from this basket**

| Sl. No. | Course Code | Course Name | L | T | P | C | Contact Hours | Type of Skill/ Focus | Prerequisites/ Corequisites |
|---|---|---|---|---|---|---|---|---|---|
| 1 | DSC4011 | Data Science with Cloud Computing | 3 | 0 | 0 | 3 | 3 | S | - |
| 2 | DSC4012 | Data Security and Access Control | 3 | 0 | 0 | 3 | 3 | S | - |
| 3 | DSC4013 | Soft Computing Techniques | 3 | 0 | 0 | 3 | 3 | S | - |
| 4 | DSC4014 | Time Series Analysis and Forecasting | 3 | 0 | 0 | 3 | 3 | S | - |
| 5 | DSC4015 | IOT Data Analytics | 3 | 0 | 0 | 3 | 3 | S | - |
| 6 | DSC4016 | Probabilistic Graph Models | 3 | 0 | 0 | 3 | 3 | S | - |
| 7 | DSC40 | Social Network Analysis | 3 | 0 | 0 | 3 | 3 | S | - |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 17 | | | | | | | | |
| 8 | DSC4018 | Application of Probability theory in Computer Science | 3 | 0 | 0 | 3 | 3 | S | - |
| 9 | DSC4019 | Digital Image Processing | 2 | 0 | 2 | 3 | 4 | S | - |
| 10 | DSC4020 | Data Mining and Pattern Recognition | 2 | 0 | 2 | 3 | 4 | S | - |
| 11 | DSC4021 | Graph Analytics and Network Science | 2 | 0 | 2 | 3 | 4 | S | - |
| 12 | DSC4022 | Geospatial Data Science | 2 | 0 | 2 | 3 | 4 | S | - |
| 13 | DSC4023 | Marketing and Consumer Analytics | 3 | 0 | 0 | 3 | 3 | S | - |
| 14 | DSC4024 | Multimodal Learning | 2 | 0 | 2 | 3 | 4 | S | - |
| 15 | DSC4025 | Intelligent Decision Support Systems | 2 | 0 | 2 | 3 | 4 | S | - |
| 16 | AIE4011 | Robotic Process Automation | 3 | 0 | 0 | 3 | 3 | S | - |
| 17 | AIE4012 | Machine Vision | 3 | 0 | 0 | 3 | 3 | S | - |
| 18 | AIE4013 | Cloud Computing | 3 | 0 | 0 | 3 | 3 | S | - |
| 19 | AIE4014 | Ontology Engineering for the Semantic Web | 3 | 0 | 0 | 3 | 3 | S | - |
| 20 | AIE4015 | Intelligent Information Retrieval | 3 | 0 | 0 | 3 | 3 | S | - |
| 21 | AIE4016 | Internet of Things | 3 | 0 | 0 | 3 | 3 | S | - |
| 22 | AIE4017 | Essentials for Machine Learning | 3 | 0 | 0 | 3 | 3 | S | - |
| 23 | AIE4018 | Recommender Systems with Machine Learning and AI | 3 | 0 | 0 | 3 | 3 | S | - |
| 24 | AIE4019 | Green Computing and Sustainable IT | 3 | 0 | 0 | 3 | 3 | S | - |
| 25 | AIE4020 | Reinforcement Learning | 2 | 0 | 2 | 3 | 4 | S | - |
| 26 | AIE4021 | AI Ethics and Responsible AI | 2 | 0 | 2 | 3 | 4 | S | - |
| 27 | AIE4022 | Generative AI and Foundation Models | 2 | 0 | 2 | 3 | 4 | S | - |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 28 | AIE4023 | Explainable AI | 2 | 0 | 2 | 3 | 4 | S | - |
| 29 | AIE4024 | Digital Twins | 2 | 0 | 2 | 3 | 4 | S | - |
| 30 | AIE4025 | Quantum Computing | 2 | 0 | 2 | 3 | 4 | S | - |

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

| **Table 3.4 Open Elective Courses Minimum of 6 Credits to be earned from this basket** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Civil Engineering Basket** | | | | | | | | | |
| **Sl. No.** | **Course Code** | **Course Name** | **L** | **T** | **P** | **C** | **Contact Hours** | Type of Skills | **Prerequisites** |
| 1 | CIV5001 | Sustainable Smart Cities | 3 | 0 | 0 | 3 | 3 | EM | - |
| 2 | CIV5002 | Systems Design for Sustainability | 3 | 0 | 0 | 3 | 3 | EM | - |
| 3 | CIV5003 | SelfSustainable Buildings | 3 | 0 | 0 | 3 | 3 | EM | - |
| 4 | CIV5004 | Energy and Buildings | 3 | 0 | 0 | 3 | 3 | EM | - |
| **Law Basket** | | | | | | | | | |
| 1 | LAW5001 | International Trade Law | 3 | 0 | 0 | 3 | 3 | - | - |
| 2 | LAW5002 | Law relating to Business Establishment | 3 | 0 | 0 | 3 | 3 | - | - |
| 3 | LAW5003 | Data Protection Law | 3 | 0 | 0 | 3 | 3 | - | - |
| 4 | LAW5004 | Law Relating to Consumer Protection | 3 | 0 | 0 | 3 | 3 | - | - |
| 5 | LAW5005 | Law Relating to Infrastructure Projects | 3 | 0 | 0 | 3 | 3 | - | - |
| **Computer Science and Engineering Basket** | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | CSE5001 | Programming Methodologies using Java | 3 | 0 | 0 | 3 | 3 | - | - |
| 2 | CSE5002 | Human Computer Interaction | 3 | 0 | 0 | 3 | 3 | - | - |
| 3 | CSE5003 | IOT Applications | 3 | 0 | 0 | 3 | 3 | - | - |
| 4 | CSE5004 | Programming Essentials in Python | 3 | 0 | 0 | 3 | 3 | - | - |
| **Electronics and Communication Engineering Basket** | | | | | | | | | |
| 1 | ECE5001 | Wearable Computing | 3 | 0 | 0 | 3 | 3 | - | - |
| 2 | ECE5002 | MEMS and Nanotechnology | 3 | 0 | 0 | 3 | 3 | - | - |
| 3 | ECE5003 | Advanced Computer Networks | 3 | 0 | 0 | 3 | 3 | - | - |
| 4 | ECE5004 | Pervasive Computing | 3 | 0 | 0 | 3 | 3 | - | - |
| **Mechanical Engineering Basket** | | | | | | | | | |
| 1 | MEC5001 | Optimization Techniques | 3 | 0 | 0 | 3 | 3 | - | - |
| 2 | MEC5002 | Industry 4.0 | 3 | 0 | 0 | 3 | 3 | EM | - |
| 3 | MEC5003 | Six Sigma for Engineers | 3 | 0 | 0 | 3 | 3 | - | - |
| 4 | MEC5004 | Design for Internet of Things | 3 | 0 | 0 | 3 | 3 | - | - |
| **Management Basket** | | | | | | | | | |
| 1 | MBA3042 | Innovation and Business Incubation | 3 | 0 | 0 | 3 | 3 | - | - |
| 2 | MBA3037 | Personal Wealth Management | 3 | 0 | 0 | 3 | 3 | - | - |
| 3 | MBA3038 | Team Dynamics | 3 | 0 | 0 | 3 | 3 | - | - |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4 | MBA3039 | Market Research | 3 | 0 | 0 | 3 | 3 | - | - |
| 5 | MBA2023 | Design Thinking for Business Innovation | 3 | 0 | 0 | 3 | 3 | - | - |
| 6 | MBA3046 | Game Theory in Business | 3 | 0 | 0 | 3 | 3 | - | - |
| 7 | MBA3047 | Data Story Telling | 3 | 0 | 0 | 3 | 3 | - | - |
| 8 | MBA3048 | Environmental Sustainability and Value Creation | 3 | 0 | 0 | 3 | 3 | - | - |
| 9 | MBA3049 | Industry 4.0 | 3 | 0 | 0 | 3 | 3 | - | - |
| **Media Studies Basket** | | | | | | | | | |
| 1 | BAJ5001 | Media and Entertainment Business | 3 | 0 | 0 | 3 | 3 | EN | - |
| 2 | BAJ5002 | TV Journalism and News Management | 2 | 0 | 2 | 3 | 4 | EM | - |
| **Research Basket** | | | | | | | | | |
| 1 | RES5001 | Research Methodology | 3 | 0 | 0 | 3 | 3 | S | - |
| 2 | RES3001 | Research Methodology | 3 | 0 | 0 | 3 | 3 | S | - |
| Research Project (Students are required to carry out research work under the guidance of a faculty member/ research scholar and the same shall be evaluated and credit will be granted as per the academic regulations) | | | | | | | | | |
| 1 | URE7001 | University Research Experience | - | - | - | 3 | | EM | - |
| 2 | URE7002 | University Research Experience | - | - | - | 0 | | EM | - |
| Apart from the above list, the student is free to enroll for any course offered by any school and earn credits for Open elective provided the student has not completed an antirequisite course and the student fulfills the prerequisite if any for the course he wishes to enroll | | | | | | | | | |

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

| Sl. No. | Course Code | Course Name | L | T | P | Credits | Contact Hours | Basket |
|---|---|---|---|---|---|---|---|---|
| **Semester 1** | | | | | | **22** | **26** | |
| 1 | MAT4011 | Advanced Engineering Mathematics | 4 | 0 | 0 | 4 | 4 | School Core |
| 2 | ENG5001 | English for Employability | 2 | 1 | 0 | 3 | 3 | School Core |
| 3 | DSC4000 | Statistics for Data Science | 3 | 0 | 0 | 3 | 3 | Program Core |
| 4 | DSC4001 | Programming in Data Science | 2 | 0 | 2 | 3 | 4 | Program Core |
| 5 | DSC4002 | Data Analytics and Visualization | 2 | 0 | 2 | 3 | 4 | Program Core |
| 6 | XXXXXX | Discipline Elective - I | 2 | 0 | 2 | 3 | 4 | Discipline Elective |
| 7 | XXXXXX | Discipline Elective - II | 2 | 0 | 2 | 3 | 4 | Discipline Elective |
| **Semester 2** | | | | | | **22** | **24** | |
| **8** | DSC4003 | Data Mining and Predictive Analytics | 2 | 0 | 2 | 3 | 4 | Program Core |
| **9** | DSC4004 | Big Data Analytics Tools and Techniques | 2 | 0 | 2 | 3 | 4 | Program Core |
| **10** | xxxxxx | Discipline Elective - III | 2 | 0 | 2 | 3 | 4 | Discipline Elective |
| **11** | xxxxxx | Discipline Elective - IV | 3 | 0 | 0 | 3 | 3 | Discipline Elective |
| **12** | xxxxxx | Discipline Elective - V | 3 | 0 | 0 | 3 | 3 | Discipline Elective |
| **13** | xxxxxx | Open Elective - I | 3 | 0 | 0 | 3 | 3 | Open Elective |
| **14** | xxxxxx | Open Elective - II | 3 | 0 | 0 | 3 | 3 | Open Elective |
| **15** | SEM7000 | Seminar | - | - | - | 1 | 0 | School Core |
| | | | | | | | | |
| **Semester 3** | | | | | | **10** | **0** | |
| **16** | PIP7500 | Dissertation/ Internship - I | - | - | - | 10 | | School Core |
| **Semester 4** | | | | | | **14** | **0** | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **17** | PIP7501 | Dissertation/ Internship - II | - | - | - | 14 | | School Core |
| | | | | | | **68** | | |

## I. Course Catalogues:

Each course shall have a course catalogue with the following details:

i) Pre –Requisites of the course
ii) Course Description
iii) Course Outcome
iv) Course Content
iv) Reference Resources.

The Course Catalogues for the Courses offered in each basket are attached below:

| | | | |
|---|---|---|---|
| Course Code: MAT4011 | Course Name: Advanced Engineering Mathematics<br>Type of Course:School core | L- T-P- C | 4-0-0-4 |
| Version No. | 1.0 | | |
| NCrF Level- | 5.0 | | |
| Course Pre-requisites | Optimization Techniques for Engineers | | |
| Co-requisites | NiL | | |
| Anti-requisites | CSEXXXX | | |
| Course Description | This course is intended to provide an in-depth theoretical background and mathematical skills that are imperative for the effective understanding of engineering problems. The topics introduced will serve as basic tools for specialized studies in many engineering fields. The course focuses on various mathematical techniques with a strong focus on modelling, simulation and solving problems relevant to the industry. The course covers topics such as linear algebra, numerical methods and optimization techniques | | |
| Course Objective | •The objective of the course is to familiarize the learners with the concepts of "Advanced Engineering Mathematics" and attain Skill Development through Problem Solving Techniques. | | |
| Course Outcomes | **On successful completion of the course the students shall be able to:**<br>**CO1:**Describe the concepts of vector spaces and linear transformations. [Level 2 - Understand]<br>**CO2**: Explain numerical methods concerning linear and nonlinear, algebraic, transcendental and differential equations. [Level 2 - Understand]<br>**CO3:**Demonstrate the use of optimization techniques to deal with real-life problems. [Level 3 – Apply]<br>**CO4:**Employ PERT and CPM techniques to tackle network problems [Level 3 – Apply] | | |
| Course Content: | | | |
| Module 1 | Linear Algebra | Assessment: Assignment | 12 Sessions |
| Topics:<br>Introduction to vector spaces and sub-spaces - definitions and illustrative examples, linearly independent and dependent vectors, basis and dimension - definitions and problems, linear transformations – definitions and examples, matrix form of linear transformations - Illustrative examples | | | |

| | | | |
|---|---|---|---|
| Module 2 | Numerical Methods | Assessment : Quiz + Assignment | 16 Sessions |
| Topics:<br>Introduction, Newton-Raphson method for system of nonlinear equations, Runge-Kutta Method for system of first order ODEs and for second order ODEs, finite difference method for boundary value problems, shooting method, finite difference method for PDEs, Crank-Nicolson method for parabolic PDEs, explicit finite difference method for hyperbolic PDEs, Gauss-Seidel iteration method for elliptical PDEs. | | | |
| Module 3 | OR and LPP | Assessment : Assignment | 16 Sessions |
| Topics:<br>Review of OR: Definition and basics of OR, characteristics of OR, OR and decision making, scope and limitations of OR, linear programming problem, formulation of LPP, graphical solution of LPP, Simplex method, transportation problem, assignment problem, travelling salesman problem. | | | |
| Module 4 | CPM, PERT and Game Theory | Assessment : Assignment | 16 Sessions |
| Topics:<br>PERT and CPM: Basic components, logical sequencing, rules of network construction, shortest-route problem, critical path analysis, PERT networks.<br>Game Theory: pure and mixed strategy, principle of dominance, solution of games with saddle point. Solution of 2*2 games by Arithmetic method, solution of 2*n and m*2 games by graphical method. | | | |
| Targeted Applications & Tools: | | | |
| The objective of the course is to familiarize students with a linear algebra, Numerical methods and variety of Optimization techniques and the theoretical concepts of Operational Research to equip them with the necessary numerical approaches and basic statistical tools to tackle engineering and real-life problems.<br>Tools used: Lindo Software (Open Source) | | | |
| Skill-Building Activities through Experiential Learning: | | | |
| • Collect and analyze real-world datasets to compute descriptive statistics and interpret results.<br>• Perform probability and hypothesis testing experiments using sample datasets.<br>• Build and evaluate regression models for prediction using Python or Excel.<br>• Create data visualizations such as histograms scatter plots and box plots to derive insights from data. | | | |
| Text Book<br>**T1:** Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley, 2017.<br>**T2:** M K Jain, S R K Iyengar, R K Jain, "Numerical methods for Scientific and Engineering Computations", 7th Edition, New Age International, 2010.<br><br>**T3:** Hamdy A Taha, "Operations Research: An Introduction", Pearson Education, 10th Edition, 2017 | | | |
| References<br>**R1:** C Ray Wylie and Louis C Barrett, "Advanced Engineering Mathematics", 6th Edition, McGraw-Hill, 2012.<br>**R2:** Glyn James and Phil Dyke, "Modern Engineering Mathematics", 6th Edition, Pearson, 2019.<br>**R3:** B S Grewal, "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, 2017.<br>**R4:** I N Herstein, "Topics in Algebra", 3rd Edition, Wiley, 1996.<br>**R5:** Steven C Chapra and Raymond P Canale, "Numerical Methods for Engineers," 7th Edition, McGraw-Hill, 2015.<br>**R6:** Kanti Swarup, P K Gupta and Man Mohan, "Operations Research", Sultan Chand & Sons, New Delhi, 2015.<br>**R7:** F S Hillier and G J Lieberman, "Introduction to Operations Research", 9th Edition, McGraw Hill-Higher Education, 2010. | | | |
| E-Resources/Web Resources<br>1. https://presiuniv.knimbus.com/user#/searchresult?searchId=numerical%20methods&_t=1677 | | | |

131676360

2. https://presiuniv.knimbus.com/user#/searchresult?searchId=operations%20research&_t=1677131909170
3. https://archive.nptel.ac.in/courses/111/105/111105035/
4. https://archive.nptel.ac.in/courses/111/107/111107105/
5. https://archive.nptel.ac.in/courses/112/101/112101298/
6. https://in.coursera.org/learn/essential-linear-algebra-for-data-science
7. https://in.coursera.org/learn/numerical-methods-engineers
8. https://in.coursera.org/learn/operations-research-modeling

| | | | |
|---|---|---|---|
| Course Code: ENG5001 | Course Name: English for Employability<br>Type of Course:School Core | L- T-P- C | 2-1-0-3 |
| Version No. | 2.0 | | |
| NCrF Level- | 5.0 | | |
| Course Pre-requisites | Graduate level English language skills | | |
| Co-requisites | NiL | | |
| Anti-requisites | CSEXXXX | | |
| Course Description | The purpose of this course is to enable students enhance their vocabulary, pronunciation and accent and thus ensuring employability. The course is designed in a structured format so as to help students internalize the content. The modules provide adequate scope for internalization through meaningful and relevant activities. An Eco-Tech Rhetoric experiential learning module integrates green computing with critical thinking and emotional intelligence. Assessments are built at regular intervals to facilitate learning. They also acquire research writing skills which enables them in academic writing. Through a blend of theory, practical application, and reflective practice, this course empowers learners to communicate effectively, think critically, and write with precision across diverse domains. | | |
| Course Objective | The objective of the course is to enhance English communication, critical thinking, and academic writing skills, integrating eco-tech rhetoric, multilingualism, and intercultural negotiation through practical simulations and reflective practice and attain Employability Skills through Participative Learning techniques. | | |
| Course Outcomes | **On successful completion of the course the students shall be able to:**<br>**CO1:**Describe main ideas and supporting details while listening attentively. [Level 2 – Understand]<br>**CO2**: Demonstrate speaking ability in English both in terms of fluency and comprehensibility. [Level 2 – Understand]<br>**CO3:**Discover reading skills, reading speed and read to analyze and interpret information. [Level 3 – Apply]<br>**CO4:**Apply the knowledge of mechanics of research writing and write a research article. [Level 3 – Apply] | | |
| Course Content: | | | |
| Module 1 | Active Listening | Assessment :Assignment | 8 Sessions |

| | | | |
|---|---|---|---|
| Topics:<br>The Lost Art of Listening, Listening to Opposing Views - Why It Feels Like Being Chased by a Bear, When to Stop Listening, Podcasts for Beginners, Intermediate and Advanced | | | |
| Module 2 | Effective Speaking | Assessment :Assignment | 8 Sessions |
| Topics:<br>Workplace Communication and Communication Etiquette, Practical frameworks to improve speaking, Attending Interviews, Asking and responding to questions, Formal and Informal Communication, Expressing views, opinions and preferences Presentation Skills- Activity, Short speeches- Activity | | | |
| Module 3 | Eco-Tech Rhetoric | Assessment :Assignment | 8 Sessions |
| Topics:<br>Critical Thinking in Green Computing:Green Technology, Nature and functions of creative and critical thinking, Emotional Intelligence | | | |
| Module 4 | Reading Strategies | Assessment :Assignment | 8 Sessions |
| Topics:<br>Components of reading, Improving thinking skills, analytical abilities, and decision making through<br><br>Reading, Reading Strategies, Reading and Note Making- Activity | | | |
| Module 5 | Scientific Writing/Writing Dissertation | Assessment :Assignment | 8 Sessions |
| Report Writing- Types of reports, Components of a Report, Structuring a Technical Report. Referencing Skills for Academic Report Writing, Writing bibliography- Activity, Writing a Research Article- Activity | | | |
| Targeted Applications & Tools: | | | |
| NA | | | |
| Skill-Building Activities through Experiential Learning: | | | |
| Abstract Conceptualization – Green Computing<br>Assign students to research a green tech topic and prepare a debate. Summarize key concepts and critically evaluate their feasibility, using evidence-based arguments<br>Reflective Observation – Critical thinking<br>Students participate in a facilitated discussion to reflect on their process. Write a short reflective journal entry in English, analyzing their emotional response and decision-making process. | | | |
| Text Book<br>**NA** | | | |
| References<br>**R1.** "You are not Listening" Kate Murphy<br>**R2.** "Getting to Yes: Negotiating Agreement Without Giving In" by Roger Fisher, William Ury, and Bruce Patton<br>**R3.** "Sustainable IT: Challenges, Postures, and Outcomes" by Robert R. Harmon and Nora Bensaou<br>**R4.** "Working with Emotional Intelligence" by Daniel Goleman<br>**R5.** "They Say / I Say: The Moves That Matter in Academic Writing" by Gerald Graff and Cathy Birkenstein<br>**R6.** "Writing Reports to Get Results: Quick, Effective Results Using the Pyramid Method" by Ron S. Blicq and Lisa A. Moretto | | | |
| E-Resources/Web Resources<br>EBook: https://owl.purdue.edu/owl/<br>Case study: EBook: https://www.pon.harvard.edu/<br>Case study: https://hcibib.org/ | | | |

| | | | |
|---|---|---|---|
| Course Code: DSC4000 | Course Name: Statistics for Data Science<br>Type of Course:PCC | L- T-P- C | 3-0-0-3 |
| Version No. | 2.0 | | |
| NCrF Level- | 5.0 | | |
| Course Pre-requisites | NIL | | |
| Co-requisites | NiL | | |
| Anti-requisites | CSEXXXX | | |
| Course Description | This course provides fundamental knowledge of statistics that underpins data science methodologies. It includes descriptive and inferential statistical methods, probability theory, hypothesis testing, regression, and multivariate analysis. The course focuses on data interpretation and statistical reasoning necessary for real-world data-driven decision-making. | | |
| Course Objective | • Understand the foundational concepts of descriptive and inferential statistics.<br>• Apply probability theory to model and analyze data uncertainty.<br>• Conduct hypothesis testing and regression analysis.<br>• Interpret statistical findings in the context of data science problems. | | |
| Course Outcomes | **On successful completion of the course the students shall be able to:**<br><br>**CO1:** Understand and describe the fundamentals of descriptive statistics and data distributions. [Level 2 - Understand]<br>**CO2**: Analyze data using statistical techniques including probability and inferential methods [Level 4 – Analyze]<br>**CO3:** Apply hypothesis testing and regression models for problem-solving. [Level 3 – Apply]<br>**CO4:** Use multivariate statistical tools to model and interpret complex data sets. [Level 3 – Apply] | | |
| Course Content: | | | |
| Module 1 | Descriptive Statistics and Data Visualization | Assessment: Assignment | 10 Sessions |
| Topics:<br>Data types and measurement scales<br>Central tendency (mean median mode)<br>Dispersion (variance standard deviation IQR)<br>Data visualization (histograms boxplots scatterplots)<br>Correlation and covariance | | | |
| Module 2 | Probability and Distributions | Assessment : Quiz + Assignment | 12 Sessions |
| Topics:<br>Basic probability rules<br>Conditional probability<br>Bayes theorem<br>Random variables<br>Probability distributions (Bernoulli Binomial Poisson Normal)<br>Expectation and variance | | | |
| Module 3 | Statistical Inference and Hypothesis Testing | Assessment : Assignment | 12 Sessions |
| Topics:<br>Sampling distributions<br>Central limit theorem<br>Confidence intervals<br>Hypothesis testing (Z-test t-test Chi-square test ANOVA) | | | |

| | | | |
|---|---|---|---|
| P-values<br>Type I and Type II errors | | | |
| Module 4 | Regression and Multivariate Analysis | Assessment : Assignment | 11 Sessions |
| Topics:<br>Simple and multiple linear regression<br>Assumptions of regression<br>R-squared<br>Residual analysis<br>Logistic regression<br>Multicollinearity<br>PCA (Principal Component Analysis)<br>Clustering basics | | | |

| Targeted Applications & Tools: | |
|---|---|
| Python | Data analysis statistical computation and machine learning |
| Jupyter Notebook | Interactive coding data visualization and experimentation |
| Microsoft Excel | Basic statistical analysis data cleaning and reporting |
| Power BI | Data visualization dashboard creation and business intelligence |

Skill-Building Activities through Experiential Learning:

- Collect and analyze real-world datasets to compute descriptive statistics and interpret results.
- Perform probability and hypothesis testing experiments using sample datasets.
- Build and evaluate regression models for prediction using Python or Excel.
- Create data visualizations such as histograms scatter plots and box plots to derive insights from data.

Text Book

**T1:** Alan Agresti and Christine A. Franklin, Statistics: The Art and Science of Learning from Data, Pearson, 5th Edition, 2023.
**T2:** Allen B. Downey, Think Stats: Probability and Statistics for Programmers, 2nd Edition, O'Reilly Media, 2014.
**T3:** Larry Wasserman, All of Statistics: A Concise Course in Statistical Inference, Springer, 2010.

References

**R1:** William Mendenhall, Robert J. Beaver, and Barbara M. Beaver, Introduction to Probability and Statistics, Cengage Learning
**R2:** Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Academic Press.
**R3:** Wichert, A. M., Sa-couto, L. (2021). Machine Learning - A Journey To Deep Learning: With Exercises And Answers. Singapore: World Scientific Publishing Company.

E-Resources/Web Resources

1. https://www.khanacademy.org/math/statistics-probability
2. https://stattrek.com/
3. https://www.coursera.org/learn/stanford-statistics

| | | | |
|---|---|---|---|
| Course Code: DSC4001 | Course Name: Programming in Data Science<br>Type of Course:PCC | L- T-P- C | 2-0-2-3 |
| Version No. | 2.0 | | |
| NCrF Level- | -- | | |
| Course Pre-requisites | NIL | | |

| | | | |
|---|---|---|---|
| Co-requisites | NiL | | |
| Anti-requisites | Python, R Programming Language | | |
| Course Description | This course introduces the core concepts of Data Science followed by programming using Python and R. This course has theory and lab component which emphasizes on understanding and programming right from Basics to Visualization in Python and R.<br>It helps the student to explore data by applying these concepts and also for effective problem solving, visualizing and analyzing | | |
| Course Objective | The objective of the course is to familiarize the learners with the concepts of Programming in Data Science and Attain Skill Development Through Experiential Learning Techniques | | |
| Course Outcomes | **On successful completion of the course the students shall be able to:**<br>**CO1:** Discuss about the process involved in Data Science . [Level 2 - Understand]<br>**CO2**: Explore Data using Python Numpy and Pandas [Level 3 – Apply]<br>**CO3**: Demonstrate Data Visualization using Matplotlib [Level 3 – Apply]<br>**CO4:** Explore Data using R and Visualize using R Graphics . [Level 3 – Apply] | | |
| Course Content: | | | |
| Module 1 | Introduction to Data Science | Assessment: Assignment + Case Studies | 10 Sessions |
| Topics:<br>Introduction to Data Science –- The field of Data Science – The various Data Science Disciplines, Connecting the Data Science Disciplines, Features of R, Data Science Techniques and Tools – Types of Data – Measures and Metrics – Descriptive Statistics – Inferential Statistics.<br>Data Science Methodology - From Problem to Approach and From Requirements to Collection, From Understanding to Preparation and From Modeling to Evaluation, From Deployment to Feedback.<br>Data Preprocessing - Data Quality Assessment, Feature Aggregation, Dimensionality Reduction, Feature Encoding. Predictive and descriptive analytics. | | | |
| Module 2 | Data Exploration using Numpy and Pandas | Assessment : Quiz + Programming | 18 Sessions |
| Topics:<br>Introduction to Python World, Motivation, Installation of **NUMPY**, Numpy Basics, Placeholders, Datatypes, Arrays, Basic Statistics, Copying, Slicing &Subsetting, Indexing, Flattening, Reshaping, Resizing, Sorting, Swapping, Dealing with Missing values.<br>**PANDAS** - the PYTHON Data Analysis Library, Motivation, Installation of PANDAS, PANDAS Data Structure, Series, Dataframe, Loading the Data, Descriptive Statistics, Indexing &ReIndexing, Renaming, Iteration, Sorting, Statistical functions, for and while loop in R, Window functions, Aggregations. Number of Missing values in single variable. Groupby Operations, Merging/Joining, Concatenation, Time Series, Working with Categorical Data and Text Data. | | | |
| Module 3 | I/O Tools and Visualization | Assessment : Assignment + Mini Project | 12 Sessions |
| **Topics:**<br>**I/O API Tools**, CSV and Textual files, Reading data in CSV or text files, Using RegExp to parse txt files, Reading txt files into parts, Writing data in CSV, Reading and Writing HTML files, Reading data from XML, Reading and Writing data from excel file, JSON Data,Data inspection<br>The **Matplotlib library**, Installation, A simple interactive chart, Adding elements to the chart, Adding a grid, Adding a legend, Converting the session to an html file, Saving your chart directly as an image, Handling date values, Chart typology, Line charts, Histograms, Bar charts, Horizontal Bar Charts, Multiseries bar charts, Pie chart. Preparing time series data. | | | |
| Module 4 | Regression and Multivariate Analysis | Assessment : Assignment + Programming | 11 Sessions |

Topics:

**R Environment**, Using R Studio, Vectors, List, Matrices, Arrays, Data Frames, Factors. Functions - Conditional Functions, User Defined Functions. Reading Data from files, Handling Missing Data, Installing Packages,

**R Graphics** – Plot, Line, Scatter Plot, Pie Charts, Bars, Histogram, Box Plots, 3D Pie Charts, 3D Scatter Plot, Visualization with GG Plot.

**R Statistics** – Dataset, Max & Min, Mean Median Mode, Subgroup Analyses, Probability Distributions, Pipes in R

**List of Laboratory Tasks:**

**Experiment No 1:** Create a Numpy array and perform the following operations on it
- **Level 1:** Basic Statistics, Copying, Slicing &Subsetting, Indexing, Flattening, Reshaping, Resizing,
- **Level 2:** Sorting, Swapping, Dealing with Missing values

**Experiment No. 2:** Create a PANDAS Data frame and perform the following operations on it
- **Level 1:** Descriptive Statistics, Indexing &ReIndexing, Renaming, Iteration, Sorting, Dealing with Missing Data
- **Level 2:** Statistical functions, Window functions, Aggregations

**Experiment No. 3:** Create a PANDAS Data frame and perform the following operations on it
- **Level 1:** Group by Operations, Merging/Joining, Concatenation,
- **Level 2:** Time Series, Categorical Data and Text Data

**Experiment No. 4:** Demonstrate Reading and Writing using IO API tools
- **Level 1**: CSV and EXCEL files, HTML and XML files,
- **Level 2:** HDF5 CPickle

**Experiment No. 5:** Using Matplotlib, Visualize the Data
- **Level 1**: Visualize the data using Line Chart, Bar Charts, Pie Chart, Histograms, Bar chart, Horizontal Bar Chart
- **Level 2:** Visualize the data using Multiseries Bar Chart, Multiseries Stacked Bar Chart

**Experiment No. 6:** Install R Studio and perform basic operations
- **Level 1:**Vectors, List, Matrices, Arrays, Data Frames, Factors,
- **Level 2:**Functions and handling Missing Data

**Experiment No. 7:** Using R graphics perform the following
- **Level 1:** Plot, Line, Scatter Plot, Pie Charts, Bars, Histogram, Box Plots,
- **Level 2:** 3D Pie Charts, 3D Scatter Plot, GG Plot

**Experiment No. 8:** Using R Statistics perform the following
- **Level 1:** Max & Min, Mean Median Mode, Subgroup Analyses,
- **Level 2:** Probability Distributions and Pipes

Targeted Applications & Tools:

- Data Exploration
- Data Visualization
- Data Analysis

**Tools**:

- Google Colab
- Anaconda
- R Studio

**Project work**

- A scenario will be given to the students to be developed as a series of Program/ Application.
- On completion of Module 2 and Module 4, students will be asked to develop a Mini Project using Python and R.

**Text Book**

T1. The essentials of Data Science, Knowledge Discovery Using R, Graham J Williams, CRC Press, 2017
T2. PYTHON Data Analysis, APRESS Publications, Fabio Nelli, 2015

References

**R1:** Comparative Approaches to using R and PYTHON for Statistical Data Analysis, Information Series Reference, 2018

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|---|
| **R2.:**Practical Data Science CookBook, APRESS Publications, 2018 |
| E-Resources/Web Resources<br>1. W1.https://presiuniv.knimbus.com/user#/home<br>2. W2.https://www.simplilearn.com/data-science-free-course-for-beginners-skillup |

| | | | |
|---|---|---|---|
| Course Code: DSC4002 | Course Name: Data Analytics and Visualization<br>Type of Course:PCC | L- T-P- C | 2-0-2-3 |
| Version No. | 1.0 | | |
| NCrF Level- | 5.0 | | |
| Course Pre-requisites | NIL | | |
| Co-requisites | CAI2500 | | |
| Anti-requisites | CSEXXXX | | |
| Course Description | The Course consists of two parts where first Part covers advanced analytics that covers topics necessary to give businesses greater insight into their data than they could ordinarily, and the Second Part covers data visualization concepts. Primary concepts include machine learning, data mining, predictive analytics, location analytics, big data analytics, and location intelligence. Visualization for Time series, Geolocated data, Correlations, connections, Hierarchies, networks, and interactivity. | | |
| Course Objective | The objective of the course is to familiarize the learners with the concepts of Data Analytics and Visualization and attain Employability Skills through participative learnning techniques. | | |
| Course Outcomes | **On successful completion of the course the students shall be able to:**<br>**CO1:** Analyze data by performing Exploratory Data Analysis. [Level 2 – Understand]<br>**CO2:** Apply techniques of Machine Learning to build Generalized Predictive Models. [Level 3 – Apply]<br>**CO3:** Explain basic concepts of Data Visualization [Level 3 – Apply]<br>**CO4:** Apply principles of Data Visualizations to provide insights from data. [Level 3 – Apply] | | |
| Course Content: | | | |
| **Module 1** | Data Analytics | Assignment: Analysis, Data Collection | 11 sessions |
| Topics:<br>Characteristics and types of data, Types of Analytics, Location Analytics, Working with Geospatial Data, Feature Engineering and Selection, Dimensionality Reduction Techniques, Common challenges faced during analysis | | | |
| **Module 2** | Advanced Analytics | Case Study : Analysis, Data Collection, Programming | 13 sessions |
| **Topics:**<br>Statistical methods for Data Analytics, Advance topics in Supervised and Unsupervised Machine Learning: Cluster Analysis, Hyper-Parameter Tuning, Measuring Performance of the Models, Model Selection, Data Mining techniques. | | | |
| **Module 3** | Introduction to Data Visualization | Assignment : Analysis, Data Collection | 9 ssessions |
| Impartance of analysis and visualization in the era of data abundance,Fundamentals of Data Visualization, Human Perception, Basic plotting techniques, Interaction concepts, Visualization techniques for Time Oriented data, Introduction to Data Visualization Tools | | | |
| **Module 4** | Application - Data Visualization | Case Study : Analysis, Data Collection, Programming | 14 sessions |
| **Topics:** | | | |

Designing effective Visualizations, Advanced Visualization Tools, Visualizing Geospatial Data, Document Visualization, Visualization Systems, Evaluating Visualizations, Visualization Benchmarking. Use cases of data visualisation.

**List of Laboratory Tasks:**

**Experiment No 1: Exploratory Data analysis**

**Level 1:** Demonstration of Tools to implement EDA

**Level 2:** Use the Dataset to analyze and summarize data, analyze anomalies, analyze Outliers, and Missing Value Treatment

**Experiment No. 2: Dimensionality Reduction Techniques**

**Level 1:** Implement DR Technique(s)

**Experiment No. 3:Machine Learning Methods**

**Level 1:** Implement Supervised Learning Techniques for the given dataset

**Level 2:** Implement Un-Supervised Learning Techniques for the given dataset and Cluster Analysis

**Experiment No. 4: Measure the Performance of the Models**

**Level 1**: Perform Model Selection

**Level 2**: Regularize the model

**Experiment No. 5: Introduction to Data Visualization Tools**

**Level 1**: Implement Basic plotting techniques

**Experiment No. 6: Time Oriented data**

**Level 1:** Visualization techniques for Time Oriented data

**Experiment No. 7: Trees, Graphs, Networks**

**Level 1:** Visualization techniques for Trees, Graphs, Networks

**Experiment No. 8: Advanced Visualization Tools**

**Level 1:** Design effective Visualizations for the given scenario

**Level 2**: Implement Visualizing of Geospatial Data and Document Visualization

**Experiment No. 9: Analyze Visualization Systems**

- **Level 1:** Analyze Visualization Systems

Targeted Applications & Tools:

1. R Programming
2. Python
3. Tableau
4. SAS
5. Excel
6. RapidMiner
7. IBM Cognos Analytics
8. Microsoft Power BI

Skill-Building Activities through Experiential Learning:

**Mini Project:**

Perform exploratory data analysis on a given dataset and provide insights on the same.

**1. Crunchbase** – Find business information about private and public companies. You can look up how many investments they had, who the founding members are, and if they had any mergers or acquisitions.

**2. Glassdoor Research** – Glassdoor offers data related to employment. You can, for example, figure out how much you can save by retaining employees.

**3. Open Corporates** – Open Corporates is the largest open database of companies and company data in the world. Used by banks and governments, they pride themselves on having the most accurate data.

4. **FBI Uniform Crime Reporting –** The Uniform Crime Reporting compiles statistical crime reports, publications, and data points from thousands of cities, universities, states, and federal law enforcement agencies.

5. **Uppsala Conflict Data Program** – The Uppsala Conflict Data Program (UCDP) provides data on organized crime and civil war around the world.

6. **National Institute on Drug Abuse** – The National Institute on Drug Abuse (NIDA) monitors the prevalence and trends regarding drug abuse in the United States.

7. **DBpedia** – DBpedia aims to make Wikipedia's information easily searchable via SPARQL queries or by downloading their information directly. For instance, you can search for NBA players born in the 80s, in cities with more than 1M inhabitants.

8. **Google Trends** – Google Trends allows you to look at what's going on in the world. It gives you data about what's becoming popular, and how much people are searching for a particular term.

9. **Instagram API** – Facebook allows you to use Instagram's API to quickly access comments, metadata, and metrics.

10. **Comtrade** – Official trade in goods and services data sets managed by the UN COMTRADE database. There are data visualization tools and an API and other extraction tools available.

11. **Datahub – StockMarket** – From gold prices, NASDAQ listings, to S&P 500 companies, you'll find it all on datahub.io

12. **Global Financial Data** – Global Financial Data gives you exactly what it says on the tin; data about the finances of the world. Ranges from real estate, global macro data, to market data.

13. **IMF Data** – The IMF, or International Monetary Fund, is an organization that aims to foster monetary collaboration between countries. You can find data on trade, government finance, and financial development.

14. **The Atlas of Economic Complexity** – The Atlas of Economic Complexity provides data about global trade dynamics over time. Want to know the quantity of textiles China exported to South Korea? Easy.

15. **World Bank** – Not only does the World Bank provide financial data about countries, but it also provides data on education and health.

16. **Financial Times Data** – Here you'll find cold, hard numbers about the different markets in the world.

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|---|
| Data include fluctuations in currency, yield rates of bonds, and commodity prices. |
| Text Book<br>**T1:** Wilke, Claus O. "Fundamentals of data visualization: a primer on making informative and compelling figures" O'Reilly Media, 2019.<br>**T2:** Ward, Grinsten, Keim. "Interactive Data Visualization: Foundations, Techniques, and Applications" A K Peters/CRC Press,2nd Edition, 2015. |
| References<br>**R1:** Mohammed J. Zaki, and Wagner Meira Jr., "Data Mining and Analysis: Fundamental Concepts and Algorithms", Cambridge University Press, 2016.<br>**R2.** I.H. Witten and E. Frank, "Data Mining: Practical Machine learning tools and techniques " Morgan Kaufmann publishers; 3rd Edition, 2011. |
| E-Resources/Web Resources<br>**W1:**.https://presiuniv.knimbus.com/user#/home<br>**W2:**https://www.geeksforgeeks.org/short-note-on-data-visualization/ |

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|---|---|---|---|
| Course Code: DSC4003 | Course Name: Data Mining and Predictive Analytics<br>Type of Course:PCC | L- T-P- C | 2-0-2-3 |
| Version No. | 1.0 | | |
| NCrF Level- | 5.0 | | |
| Course Pre-requisites | Basic Statistics and Programming | | |
| Co-requisites | | | |
| Anti-requisites | | | |
| Course Description | This course introduces fundamental concepts, techniques, and algorithms used in data mining and predictive analytics. Emphasis is placed on extracting meaningful patterns from data and applying predictive models for classification, regression, clustering, and association rule mining. The course integrates hands-on experience through labs and tools. | | |
| Course Objective | • Understand the foundations and applications of data mining.<br>• Explore different data preprocessing and transformation techniques.<br>• Apply classification, clustering, and association rule mining algorithms.<br>• Evaluate and interpret predictive models using appropriate metrics. | | |
| Course Outcomes | **On successful completion of the course the students shall be able to:**<br>**CO1**: Apply data preprocessing techniques to prepare real-world datasets for mining and predictive modeling tasks. [Level 3 – Apply]<br>**CO2:** Analyze data mining techniques and data preparation methods. [Level 4 – Analyze]<br>**CO3:** Examine predictive modeling approaches for classification and regression tasks. [Level 4 – Analyze]<br>**CO4:** Apply clustering and association rule mining algorithms on datasets. [Level 3 – Apply]<br>**CO5:** Implement data mining solutions using real-world datasets and tools. [Level 3 – Apply]<br>**CO6:** Build and deploy predictive analytics solutions and interpret their applications in real-life domains such as marketing, finance, and healthcare, including time series forecasting [Level 6 – Create ] | | |
| Course Content: | | | |
| **List of Laboratory Tasks:**<br>1. Data cleaning and preprocessing using Python or R. | | | |

2. Feature selection and transformation techniques.
3. Implement decision tree classifier and evaluate using metrics.
4. Apply Naïve Bayes and K-NN classifiers.
5. Perform logistic regression for binary classification.
6. Train and test SVM on real dataset.
7. Build a K-means clustering model and visualize clusters.
8. Implement hierarchical clustering and interpret dendrograms.
9. Apply DBSCAN for density-based clustering.
10. Extract association rules using Apriori algorithm.
11. Perform FP-Growth and analyze rule significance.
12. Cross-validation and hyperparameter tuning.
13. Build a predictive model on time series data.
14. Model deployment using Flask/Streamlit.
15. Mini project on end-to-end predictive analytics solution.

Targeted Applications & Tools:

| | |
|---|---|
| Python | A versatile programming language used for data mining, machine learning, predictive analytics, and data visualization. |
| Weka | An open-source data mining tool used for classification, clustering, association rule mining, and predictive modeling. |
| RapidMiner | A visual workflow-based platform used for predictive analytics, machine learning, and business intelligence applications. |
| Orange Data Mining | A visual programming tool used for interactive data analysis, machine learning, and data visualization. |
| R Programming Language | A programming language and software environment used for statistical computing, predictive modeling, and data analysis. |

Skill-Building Activities through Experiential Learning:

- **Data Preprocessing with Real-World Datasets**
  Learners perform hands-on preprocessing of real-world datasets (e.g., UCI, Kaggle) by handling missing values, scaling features, and encoding categorical variables. This foundational step helps them understand the impact of clean data on model performance.

- **Exploratory Data Analysis and Visualization**
  Using libraries such as Matplotlib and Seaborn, students conduct exploratory data analysis through plots like scatter plots, heatmaps, and pair plots. Visualizations are used to identify patterns, correlations, and anomalies before model building.

- **Model Building with Supervised Learning Algorithms**
  Students implement regression and classification algorithms—Linear Regression, Logistic Regression, Naïve Bayes, and SVM—on structured datasets. They analyze model predictions using decision boundaries, ROC curves, and learning curves.

Text Book

**T1:** Jiawei Han, Micheline Kamber, and Jian Pei, *Data Mining: Concepts and Techniques*, 3rd Edition, Morgan Kaufmann, 2011.
**T2:** Trevor Hastie, Robert Tibshirani, and Jerome Friedman, *The Elements of Statistical Learning*, Springer, 2nd Edition.

References

R1: Ian H. Witten, Eibe Frank, Mark A. Hall, *Data Mining: Practical Machine Learning Tools and Techniques*, Elsevier.
R2: Galit Shmueli, Nitin R. Patel, Peter C. Bruce, *Data Mining for Business Analytics*, Wiley.

E-Resources/Web Resources

1. [W1] https://www.kaggle.com/learn
2. [W2] https://scikit-learn.org/stable/
3. [W3] https://www.datacamp.com/

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|---|---|---|---|
| Course Code: DSC4004 | Course Name: Big Data Analytics Tools and Techniques<br>Type of Course:PCC | L- T-P- C | 2-0-2-3 |
| Version No. | 1.0 | | |
| NCrF Level- | 5.0 | | |
| Course Pre-requisites | NIL | | |
| Co-requisites | NiL | | |
| Anti-requisites | AIE4002 | | |
| Course Description | This course is designed to provide the fundamental knowledge to equip students being able to handle real-world big data problems including the three key resources of Big Data: people, organizations and sensor. With the advancement of IT storage, processing, computation and sensing technologies. It helps the students to interpret the operational concepts of computer technology as well as performance enhancement | | |
| Course Objective | The objective of the course is to familiarize the learners with the concepts of Big Data Analytics Tools and Techniques and attain employability skills through experiential leaning techniques | | |
| Course Outcomes | **On successful completion of the course the students shall be able to:**<br>**CO1:** Understand managing big data using Hadoop analytical tools and technologies [Level 2 - Understand]<br>**CO2**: Understand map-reduce analytics using Hadoop and related tools [Level 2 - Understand]<br>**CO3:** Preparing for data summarization, query, and analysis. [Level 3 – Apply]<br>**CO4:** Applying data modeling techniques to large data sets [Level 3 – Apply]<br>**CO5:** Building a complete business data analytic solution [L6 – Create] | | |

Course Content:

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|---|---|---|---|
| Module 1 | Introduction to Hadoop and HDFS | Assignment:Data Collection and Analysis | 8 Sessions |

Topics:

Meet Hadoop: Data, Data Storage and Analysis, Comparison with Other Systems: Relational Database Management Systems, Grid Computing, Volunteer Computing Hadoop Fundamentals Map Reduce A Weather Dataset: Data Format, Analyzing the Data with Unix Tools, Analyzing the Data with Hadoop: Map and Reduce, Java Map Reduce, Scaling Out: Data Flow, Combiner Functions, Running a Distributed Map Reduce Job, Hadoop Streaming , Characteristics of big data, Challenges in processing big data, Limitations of classical algorithms on big data

The Hadoop Distributed File system: The Design of HDFS, HDFS Concepts: Blocks, Name nodes and Data nodes, HDFS Federation, HDFS High-Availability, The Command-Line Interface, Basic File system Operations, Hadoop File systems Interfaces, The Java Interface, Reading Data from a Hadoop URL, Reading Data Using the File System API, Writing Data, Directories, Querying the File system, Deleting Data, Data Flow: Anatomy of a File Read, Anatomy of a File Write, Using Hadoop archives, limitations.

| | | | |
|---|---|---|---|
| Module 2 | YARN and Hadoop I/O | Assignment:Data Collection and Analysis | 8 Sessions |

Topics:
YARN Anatomy of a YARN Application Run: Resource Requests, Application Lifespan, Building YARN Applications, YARN Compared to Map Reduce, Scheduling in YARN: The FIFO Scheduler, The Capacity Scheduler, The Fair Scheduler, Delay Scheduling, Dominant Resource Fairness

Hadoop I/O: Data Integrity in HDFS, Local File System, Checksum File System, Compression and Input Splits, Using Compression in Map Reduce, Serialization, The Writable Interface, Writable Classes, Implementing a Custom Writable, Serialization Frameworks, File-Based Data Structures: Sequence File

| Module 3 | Map Reduce Applications | Case Study:Data Analysis | 8 Sessions |
|---|---|---|---|

Topics:
Developing a Map Reduce Application: The Configuration API, Combining Resources, Variable Expansion, Setting Up the Development Environment, Managing Configuration, Generic Options Parser, Tool, and Tool Runner, Writing a Unit Test with MR Unit: Mapper, Reducer, Running Locally on Test Data, Running a Job in a Local Job Runner, Testing the Driver, Running on a Cluster, Packaging a Job, Launching a Job, The Map Reduce Web UI, Retrieving the Results, Debugging a Job, Hadoop Logs, Tuning a Job, Profiling Tasks, Map Reduce Workflows: Decomposing a Problem into Map Reduce Jobs, Job Control, Apache Oozie

How Map Reduce Works: Anatomy of a Map Reduce Job Run, Job Submission, Job Initialization, Task Assignment, Task Execution, Progress and Status Updates, Job Completion, Failures: Task Failure, Application Master Failure, Node Manager Failure, Resource Manager Failure, Shuffle and Sort: The Map Side, The Reduce Side, Configuration Tuning, Task Execution: The Task Execution Environment, Speculative Execution, Output Committers

| Module 4 | Map Reduce Types and Formats, Flume | Case Study:Data Analysis | 10 Sessions |
|---|---|---|---|

Topics:
Map Reduce Types, Input Formats: Input Splits and Records Text Input, Binary Input, Multiple Inputs, Database Input (and Output) Output Formats: Text Output, Binary Output, Multiple Outputs, Lazy Output, Database Output

Flume Installing Flume, An Example, Transactions and Reliability, Batching, The HDFS Sink, Partitioning and Interceptors, File Formats, Distribution: Agent Tiers, Delivery Guarantees, Sink Groups, Integrating Flume with Applications, Component Catalog

| **Module 5** | Hive, Pig, Spark Analytical Tools | Case Study:Data Analysis | 10 Sessions |
|---|---|---|---|

Topics:
Hive Apache Hive with Hive Installation, Hive Data Types, Hive Table partitioning, Hive DDL commands, Hive DML commands, Hive sort by vs order by, Hive Joining tables

Pig Installing and Running Pig, Execution Types, Running Pig Programs, Grunt, Pig Latin Editors, An Example: Generating Examples, Comparison with Databases, Pig Latin: Structure, Statements, Expressions, Types, Data Processing Operators: Loading and Storing Data, Filtering Data, Grouping and Joining Data, Sorting Data, Combining and Splitting Data.

Spark An Example: Spark Applications, Jobs, Stages and Tasks, A Java Example, A Python Example, 20082020 / 31 Resilient Distributed Datasets: Creation, Transformations and Actions, Persistence, Serialization, Shared Variables, Broadcast Variables, Accumulators, Anatomy of a Spark Job Run, Job Submission, DAG Construction, Task Scheduling, Task Execution, Executors and Cluster Managers: Spark on YARN

**List of Laboratory Tasks:**

1. (i) Perform setting up and Installing Hadoop in its two operating modes:
   - Pseudo distributed,
   - Fully distributed.

   (ii) Use web based tools to monitor your Hadoop setup.

**Level 1:** Programming assignment to install the Hadoop environment tools.

2. (i) Implement the following file management tasks in Hadoop:

- Adding files and directories
- Retrieving files
- Deleting files

(ii) Benchmark and stress test an Apache Hadoop cluster

**Level 1:** Programming assignment to maintain the Hadoop Distributed File System.

3. Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm.

- Find the number of occurrence of each word appearing in the input file(s)
- Performing a Map Reduce Job for word search count (look for specific keywords in a file)

**Level 1:** Programming scenario to use map reduce programming to perform the analysis.
**Level 2:** Programming assignment to analyze the data for any given data file.

4. Stop word elimination problem:

Input:

- A large textual file containing one sentence per line
- A small file containing a set of stop words (One stop word per line)

Output:

A textual file containing the same sentences of the large input file without the words appearing in the small file.

5. Write a Map Reduce program that mines weather data. Weather sensors collecting data every hour at many locations across the globe gather large volume of log data, which is a good candidate for analysis with Map Reduce, since it is semi structured and record-oriented. Data available at: https://github.com/tomwhite/hadoopbook/tree/master/input/ncdc/all.

- Find average, max and min temperature for each year in NCDC data set?
- Filter the readings of a set based on value of the measurement, Output the line of input files associated with a temperature value greater than 30.0 and store it in a separate file.

**Level 2:** Programming assignment to analyze the social media data for business analytics.

6. For Purchases.txt Dataset , instead of breaking the sales down by store, give us a sales breakdown by product category across all of our stores.

- What is the value of total sales for the following categories?

  i.Toys
  ii.Consumer Electronics

- Find the monetary value for the highest individual sale for each separate store

  What are the values for the following stores?
  i.Reno
  ii.Toledo
  iii. Chandler
- Find the total sales value across all the stores, and the total number of sales.

**Level 2:** Programming assignment to analyze and find the maximum sales, minimum sales and average sales in each store.

7. Install and Run Pig then write Pig Latin scripts to sort, group, join, project, and filter your data.

**Level 1:** Programming scenarios to perform the grouping, filtering and Joining.

8. Write a Pig Latin scripts for finding TF-IDF value for book dataset (A corpus of eBooks available at: Project Gutenberg)
**Level 2:** Programming Assignment to analyze the data from the given text file using Pig latin script.

9. Install and Run Hive then use Hive to create, alter, and drop databases, tables, views, functions, and indexes.
**Level 1:** Programming scenario to analyze the data from the given text file to perform SQL operations.

10. Install, Deploy & configure Apache Spark Cluster. Run apache spark applications using Scala.
**Level 1:** Programming scenario to analyze a dataset using spark.

11. Data analytics using Apache Spark on Amazon food dataset, find all the pairs of items frequently reviewed together.

Write a single Spark application that:

- Transposes the original Amazon food dataset, obtaining a Pair RDD of the type:
- Counts the frequencies of all the pairs of products reviewed together;
- Writes on the output folder all the pairs of products that appear more than once and their frequencies. The pairs of products must be sorted by frequency.

**Level 2:** Programming assignment to analyze the data using spark.

Targeted Applications & Tools:

| | |
|---|---|
| Apache Hive | Data Warehousing, Querying, and Business Intelligence |
| Apache HBase | Real-Time Big Data Storage and Retrieval |
| Apache Spark | Fast Data Analytics and Predictive Modeling |
| Apache Pig | Data Transformation and Processing |
| Apache Hive | Data Warehousing, Querying, and Business Intelligence |

Skill-Building Activities through Experiential Learning:

- After completion of each module a programming based Assignment/Assessment will be conducted.
- A scenario will be given to the student to be developed as a data analysis application.
- On completion of Module 5, student will be asked to develop a project for Data Analysis.

Text Book

**T1.** Hadoop: The Definitive Guide Tom White O'Reilley Third Edition, 2012

References

R1.SPARK: The Definitive Guide MateiZaharia and Bill Chambers Oreilly 2018

R2.Apache Flume: Distributed Log Collection for Hadoop . D'Souza and Steve Hoffman Oreilly 2014

E-Resources/Web Resources

W1.https://presiuniv.knimbus.com/user#/home

W2. Data Analytics: What It Is, How It's Used, and 4 Basic Techniques (investopedia.com)

| **Course Code:** **SEM7000** | **Course Title: Seminar** **Type of Course: School Core** | **L-T-P-C** | 0-0-0-1 |
|---|---|---|---|
| **Version No.** | 1.0 | | |
| **Course Pre-requisites** | **NIL** | | |
| **Anti-requisites** | **NIL** | | |

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|---|---|
| **Course Description** | This course provides expertise in practice, and assess effective scientific seminar techniques. The seminar report writing process is also covered in the course, which calls for students to be able to connect theories, research questions, and experiment design. The seminars will assist students in acquiring the abilities needed to effectively compete for positions in various research domains. The presentation abilities they learn in the process will be crucial throughout their entire professional careers. These abilities will enable students to respond to constructive criticism and work to explain scientific concepts to peers, other scientists, and the general public. |
| **Course Outcome** | **On successful completion of this course the students shall be able to:**<br>CO1 Identify and research a current, relevant technical topic through literature surveys from reputed journals and technical reports. — Understand<br>CO2 Examine complex technical information to identify research gaps or practical applications. — Analyze<br>CO3 Prepare a comprehensive technical report, organizing information logically with appropriate citations and references. — Apply<br>CO4 Produce effective audio-visual aids (presentations) that clearly communicate technical concepts. — Apply<br>CO5 Deliver a structured oral presentation, demonstrating effective communication skills and confidence in answering technical queries. — Apply |
| **Course Content:** | Research articles / publications corresponding to a particular domain of interest will be presented |
| **Targeted Application & Tools that can be used:** | |
| 1. Emerging areas in engineering and science based research domains.<br>2. Research articles and Journals<br>3. TED Talks<br>4. You Tube Links | |
| **Text Book** NA | |
| **References** NA | |

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|---|---|---|---|
| **Course Code:** **PIP7500** | **Course Title: Dissertation / Internship – I**<br>**Type of Course: School Core** | **L-T-P-C** | 0-0-0-10 |
| **Version No.** | 1.0 | | |
| **Course Pre-requisites** | Successful completion of all prescribed coursework and approval of the dissertation/internship proposal. | | |
| **Anti-requisites** | **NIL** | | |
| **Course Description** | This course provides students with an opportunity to undertake the first phase of a dissertation or industry internship under the guidance of a faculty supervisor and/or industry mentor. Students identify a research problem or industrial challenge, conduct an extensive literature survey, define objectives, formulate an appropriate methodology, and initiate the research or implementation work. The course develops research aptitude, analytical thinking, technical documentation, project planning, and professional ethics while preparing students for the successful completion of their dissertation or internship. | | |

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| **Course Objectives** | • To identify a relevant research problem or industry-based project.<br>• To conduct a comprehensive literature survey and identify research gaps.<br>• To formulate objectives and develop an appropriate research methodology.<br>• To initiate the implementation of the proposed work and document the progress.<br>• To develop research, technical writing, and presentation skills. |
| **Course Outcome** | **On successful completion of this course the students shall be able to:**<br>CO1: Identify and formulate a research problem or industrial project based on current technological needs.<br>Level 3 – Apply<br><br>CO2: Analyze existing literature to identify research gaps and select an appropriate methodology.<br>Level 4 – Analyze<br><br>CO3: Plan and initiate the implementation of the proposed dissertation or internship work using suitable tools and techniques.<br>Level 3 – Apply<br><br>CO4: Prepare technical documentation and effectively present the progress of the dissertation or internship work.<br>Level 3 – Apply |
| **Course Content:** | Students shall carry out the initial phase of the dissertation or internship work, including problem identification, literature survey, formulation of objectives, methodology design, implementation planning, progress review, and preparation of the Phase-I dissertation/internship report under the guidance of the faculty supervisor and/or industry mentor. |
| **Targeted Application & Tools that can be used:** | |
| 1. IEEE Xplore, SpringerLink, ACM Digital Library, ScienceDirect.<br>2. Google Scholar.<br>3. Mendeley / Zotero for reference management.<br>4. Microsoft Word / LaTeX for technical documentation.<br>5. Python, MATLAB, R or domain-specific software tools (as applicable).<br>6. GitHub for version control and collaboration. | |
| **Text Book** NA | |
| **References** NA | |

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|---|---|---|---|
| **Course Code:** **PIP7501** | **Course Title: Dissertation / Internship – I**<br>**Type of Course: School Core** | **L-T-P-C** | 0-0-0-14 |
| **Version No.** | 1.0 | | |
| **Course Pre-requisites** | Successful completion of Dissertation / Internship – I (PIP7500). | | |
| **Anti-requisites** | **NIL** | | |
| **Course Description** | This course focuses on the successful completion of the dissertation or industry internship initiated in Dissertation/Internship – I. Students carry out the implementation of the proposed methodology, perform experimentation, analyze and validate results, and document their findings in the form of a dissertation or internship report. The course emphasizes research methodology, innovation, technical writing, professional ethics, and effective presentation of research outcomes through seminars and viva-voce examinations. | | |

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| **Course Objectives** | To complete the implementation of the proposed dissertation or internship work.<br>To analyze and validate the obtained results using appropriate techniques.<br>To prepare a comprehensive dissertation or internship report.<br>To enhance research, technical writing, and presentation skills.<br>To demonstrate professional competence through seminar presentations and viva-voce. |
| **Course Outcome** | **On successful completion of this course the students shall be able to:**<br>CO1: Complete the implementation of the proposed dissertation or internship work by applying appropriate tools and methodologies.<br>Level 3 – Apply<br><br>CO2: Analyze, validate, and interpret the results obtained from the research or industrial project.<br>Level 4 – Analyze<br><br>CO3: Prepare a comprehensive dissertation or internship report following standard technical writing and research ethics practices.<br>Level 3 – Apply<br><br>CO4: Present and defend the dissertation or internship work effectively through seminars and viva-voce with professional communication skills.<br>Level 3 – Apply |
| **Course Content:** | Students shall complete the implementation of the dissertation or internship work initiated in Phase-I. The course includes experimentation, result analysis, validation, performance evaluation, technical documentation, dissertation/internship report preparation, seminar presentation, and final viva-voce examination under the guidance of the faculty supervisor and/or industry mentor. |
| **Targeted Application & Tools that can be used:** | |
| 1. IEEE Xplore, SpringerLink, ACM Digital Library, ScienceDirect.<br>2. Google Scholar.<br>3. Mendeley / Zotero for reference management.<br>4. Microsoft Word / LaTeX for dissertation preparation.<br>5. Python, MATLAB, R or domain-specific software tools (as applicable).<br>6. GitHub for version control and collaboration.<br>7. Microsoft PowerPoint for seminar presentation. | |
| **Text Book** NA | |
| **References** NA | |

**ELECTIVES**

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|---|---|---|---|
| Course Code: DSC4011 | Course Name: Data Science with cloud computiing<br>Type of Course:Discipline Elective Theory Course | L- T-P- C | 3-0-0-3 |
| Version No. | 2.0 | | |
| NCrF Level- | 5.0 | | |
| Course Pre-requisites | NIL | | |
| Co-requisites | NiL | | |
| Anti-requisites | CSEXXXX | | |

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| Course Description | This course introduces a new Transformative, more collaborative way of doing Data Science. It helps in understanding End to End Data pipelines, Ingesting Data in a serverless way and working our way through Data Exploration, Dashboards, and Streaming Data all the way to training and making an operational Machine Learning Model.. |
| Course Objective | The objective of the course is to familiarize the learners with the concepts of Data Science with Cloud Computing and attain EMPLOYABILITY SKILLS through PARTICIPATIVE LEARNING techniques |
| Course Outcomes | **On successful completion of the course the students shall be able to:**<br><br>**CO1:**Define Data Science and its fundamentals and the process in Data Science. [Level 1 - Remember]<br>**CO2**: Explain the process of Ingesting Data into the Cloud Platform. [Level 2 – Understand]<br>**CO3:**Analyze real-world problems with Accuracy. [Level 4 – Analyze]<br>**CO4:**Demonstrate the overall organization of Data and Storage. [Level 3 – Apply] |

Course Content:

| | | | |
|---|---|---|---|
| Module 1 | Making Better Decisions Based on Data | Assessment: Case study | 10 Sessions |
| Topics:<br>Many Similar Decisions, Role of Data Engineers, The Cloud Makes Data Engineers Possible, TheNaN value, Series CRUD, Series Indexing, The Cloud Turbocharges Data science, Airline on Time Performance Data, Scheduling Monthly Downloads. | | | |
| Module 2 | Creating Compelling Dashboards | Assessment :Case study | 10 Sessions |
| Topics:<br>Explain your Model with Dashboards, Loading Data into google Cloud SQL, Creating Google cloud Instance, Interacting with Google cloud Platform, Maximum Likelihood Estimation (MLE) | | | |
| Module 3 | Streaming Data: Publication and Ingest | Assessment :Case study | 10 Sessions |
| Topics:<br>Designing the Event Feed, Time Correction, Apache Beam/Cloud Dataflow, Publishing an Event Stream to Cloud Pub/Sub, Real Time Stream processing, Interactive Data Exploration, Exploratory Data Analysis, Loading Flights Data into Big Query, Arrival Delay conditioned on Departure Delay, Evaluating the Model. Time Series Analysis | | | |
| Module 4 | Cloud Dataproc | Assessment :Case study | 10 Sessions |
| Topics:<br>Bayes Classifier on Cloud Dataproc, Map Reduce and Hadoop Eco System, Quantization using Spark SQL, Bayes Classification using Pig | | | |

Targeted Applications & Tools:

Targeted Industries like Banking, Transport, e-commerce, healthcare and many more are using data science to make optimal Decisions. The usage of data science helps in rising sales. It can explore historic data, make comparisons and analyses of the market and provide recommendations.
Target Jobs Data Scientist, Data Architect, Data Engineer, Statistician.
Tools:
Apache Spark
Jupyter
Weka

Skill-Building Activities through Experiential Learning:

Mini Project:

- Walmart Sales Forecasting in Cloud
- Predict the sales across various departments in each store.

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| • Predict the effect of markdowns on the sales during the holiday seasons.<br>Term Assignments:<br>• Consider a Dataset on Bird communities that needs to be analyzed. The data has three columns, a date, a common name, and a count of the number of individuals.<br>• Count the total number of individuals of each species that were seen in each data file.<br>• Sort based on the total number of individuals. |
| Text Book<br>**T1:** "Data Science on the Google Cloud Platform: Implementing End-to-End Real-Time Data Pipelines: From Ingest to Machine Learning"-Valiappa Lakshmanan,1st Edition, January 2018.<br>**T2:** "Data Analysis in The Cloud"- Domenico Talia ,1st Edition, September 2015 |
| References<br>**R1:** Doing Data Science, Straight Talk from the Frontline. O'Reilly. 2014. |
| E-Resources/Web Resources<br>1. https://presiuniv.knimbus.com/user#/home<br>2. https://www.geeksforgeeks.org/why-cloud-computing-is-important-in-data-science/ |

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|---|---|---|---|
| Course Code: DSC4012 | Course Name: Data Security and Access Control<br>Type of Course: Theory Course | L- T-P- C | 3-0-0-3 |
| Version No. | 2.0 | | |
| NCrF Level- | 5.0 | | |
| Course Pre-requisites | NIL | | |
| Co-requisites | NiL | | |
| Anti-requisites | CSEXXXX | | |
| Course Description | This course describes fundamental issues and problems in data security and provides technical solutions or facets to the problem of achieving data security. The course also deals with the security of statistical databases, discusses authorization systems, and covers the fundamental ideas of cryptography. | | |
| Course Objective | The objective of the course is to familiarize the learners with the concepts of Data Security and Access Control and attain employability skills through Participative Learning techniques. | | |
| Course Outcomes | **On successful completion of the course the students shall be able to:**<br>**CO1:**Describe the fundamental concepts and principles of data security including confidentiality, integrity, availability, and security models. [Level 2 - Understand]<br>**CO2**: Analyze security problems in computing systems and classical encryption standards. [Level 4 – Analyze]<br>**CO3:**Apply data security techniques such as data masking, data erasure, backup storage, and anti-malware protection to safeguard data [Level 3 – Apply]<br>**CO4:**Examine authorization mechanisms and access control models to address security challenges in networked systems [Level 4 – Analyze]<br>**CO5:**Design and simulate secure access control mechanisms using appropriate data security algorithms [Level 3 – Apply] | | |

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| | and tools<br>**CO6:** Evaluate data security policies, regulatory frameworks (GDPR, Indian Data Protection Act), and organizational security practices. | [Level 5 – Evaluate] |

| Course Content: | | | |
|---|---|---|---|
| Module 1 | Fundamentals of Data Security | Assessment: Assignment | 10 Sessions |
| Topics:<br>Introduction to Data Security, Confidentiality, Integrity, Availability<br>Visibility<br>Automation<br>Monitoring<br>Models and Methodology<br>The Security Problem in Computing<br>The Data Encryption Standard | | | |
| Module 2 | Data Security Techniques | Assessment :Demonstration | 12 Sessions |
| Topics:<br>Introduction, data masking, data erasure, and backup storage<br>Anti-malware protection<br>Viruses and other malicious code<br>Security in Key specified model<br>Security in Characteristic specified model<br>File Protection Mechanisms. | | | |
| Module 3 | Authorization Mechanisms in Data Security: | Assessment : Assignment | 12 Sessions |
| Topics:<br>Introduction, concept of Un-decidability<br>Authorization Systems with Tractable Safety Problem<br>Grammatical Authorization Systems<br>Threats in Network<br>Network Security Controls. | | | |
| Module 4 | An Overview of Data Security Tools, Data Security Policies : | Assessment :Quiz and Demonstration | 11 Sessions |
| Topics:<br>Introduction to tools available for Data Security<br>Demonstration of Security features in Linux platform<br>Simulation using more than two computers<br>Ddemonstration of data leakage during transmission<br>GDPR (General Data Protection Regulation)<br>Comparative study with India regulation, Data Privacy Act<br>Role Based Access Control<br>Organizational Security policies. | | | |

| Targeted Applications & Tools: | |
|---|---|
| Linux (Ubuntu/Kali Linux) | User Authentication and Authorization Systems |
| Wireshark | Network Security Monitoring and Traffic Analysis |

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|---|---|
| VirtualBox / VMware | Security Testing and Virtualized Security Labs |

Skill-Building Activities through Experiential Learning:

- Simulate unauthorized access attempts and evaluate access control effectiveness.
- Analyze network packets using Wireshark to identify security vulnerabilities.
- Configure user accounts, groups, and permissions in Linux..

Text Book

**T1:**Data Privacy and Security, David Solomon, Springer, 2020.

**T2:** Principles of Data Security, Ernst L. Leiss, Plenum Press, New York and London, 2021.

References

**R1:**Intelligence and Security Informatics for International Security, Chen, Hsinchun, Springer Publication, 2006.

**R2:**Certified Information Security Professional (CSIP) web portal.

E-Resources/Web Resources

4. https://presuniv.knimbus.com/user#/home
5. https://www.datasunrise.com/professional-info/what-is-access-control/

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|---|---|---|---|
| Course Code: DSC4013 | Course Name: Soft computing Techniques<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 | NiL | | |
| Anti-requisites | CSEXXXX | | |
| Course Description | This course introduces the principles of soft computing techniques and their applications in Data Science. Unlike hard computing, soft computing approaches are tolerant of imprecision, uncertainty, and approximation, making them highly effective for real-world data-driven problems. The course covers fuzzy logic, artificial neural networks, evolutionary computation, swarm intelligence, and hybrid models, with an emphasis on how these methods can be applied to solve optimization, classification, clustering, and prediction problems in Data Science. | | |
| Course Objective | •To understand the foundational concepts of soft computing and its role in Data Science.<br>•To analyze fuzzy systems, neural networks, and evolutionary algorithms for intelligent problem-solving.<br>•To apply soft computing techniques for modeling, optimization, and prediction.<br>•To design hybrid soft computing systems and interpret their applications in real-world Data Science domains. | | |
| Course Outcomes | **On successful completion of the course the students shall be able to:**<br><br>**CO1:** Understand the basics of fuzzy logic, neural networks, and evolutionary algorithms. [Level 2 - Understand]<br>**CO2**: Analyze fuzzy sets, inference systems, and clustering methods for decision-making. [Level 4 – Analyze]<br>**CO3:** Analyze neural networks and evolutionary algorithms for data-driven problem solving. [Level 4 – Analyze]<br>**CO4:** Apply hybrid soft computing and swarm intelligence to Data Science applications. [Level 3 – Apply] | | |

Course Content:

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|---|---|---|---|
| Module 1 | Introduction to Soft Computing | Assignment : Soft Computing Applications Survey | 10 Sessions |

Topics:
Soft computing vs. hard computing; need and applications in Data Science; components of soft computing – fuzzy logic, neural networks, evolutionary algorithms, and probabilistic reasoning; real-world case studies in approximation and uncertainty handling.

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| Module 2 | Fuzzy Logic and Systems | Assignment : Design of a Fuzzy Rule-Based System | 11 Sessions |

Topics:
Fuzzy sets and membership functions; fuzzy operations and relations; fuzzy rule-based systems; fuzzy inference mechanisms (Mamdani and Sugeno models); fuzzy clustering (Fuzzy C-Means); applications in decision-making, pattern recognition, and classification.

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| Module 3 | Artificial Neural Networks and Evolutionary Computation | Assignment : Neural Network Implementation | 12 Sessions |

Topics:
Biological vs. artificial neurons; feedforward networks, multilayer perceptrons; backpropagation learning algorithm; Hopfield networks; introduction to deep learning as soft computing; evolutionary algorithms – genetic algorithms, genetic programming, and applications in optimization and feature selection.

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| Module 4 | Hybrid Soft Computing and Swarm Intelligence | Assignment : Swarm Intelligence Study | 12 Sessions |

Topics:
Hybrid systems – neuro-fuzzy, genetic-fuzzy, and neuro-genetic models; swarm intelligence – particle swarm optimization (PSO), ant colony optimization (ACO); rough sets; applications in big data analytics, clustering, anomaly detection, and predictive modeling in cloud and IoT environments; emerging trends in soft computing for Data Science.

Targeted Applications & Tools:

| | |
|---|---|
| RapidMiner | Predictive Analytics and Knowledge Discovery |
| DEAP | Genetic Algorithm-Based Optimization and Feature Selection |
| PyGAD | Evolutionary Computing and Optimization Problems |
| PySwarms | Particle Swarm Optimization for Resource Allocation and Routing |

Skill-Building Activities through Experiential Learning:

- Compare hard computing and soft computing techniques for solving real-world problems involving uncertainty and imprecision.
- Design fuzzy membership functions and rule-based systems for decision-making applications such as temperature control, risk assessment, and performance evaluation.
- Implement fuzzy inference systems using software tools and analyze their effectiveness in handling uncertain data.
- Perform clustering and classification of datasets using Fuzzy C-Means and compare the results with conventional techniques.

Text Book

**T1:** S. N. Sivanandam and S. N. Deepa, *Principles of Soft Computing*, Wiley India, 2nd Edition, 2011.

**T2:** Kwang H. Lee, *First Course on Fuzzy Theory and Applications*, Springer, 2005.

References

**R1:** J. S. R. Jang, C. T. Sun, and E. Mizutani, Neuro-Fuzzy and Soft Computing, Prentice Hall, 1997.
**R2:** S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications, PHI Learning, 2017.
**R3:** David E. Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning, Addison Wesley, 1989.

E-Resources/Web Resources

[W1] https://towardsdatascience.com/ (search: fuzzy logic, GA, ANN, PSO)
[W2] Difference between Soft Computing and Hard Computing - GeeksforGeeks
[W3] Need for Soft Computing - GeeksforGeeks
[W4] Probabilistic Reasoning in Artificial Intelligence - GeeksforGeeks

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|---|---|---|---|
| Course Code: DSC4014 | Course Name: Time Series Analysis and Forecasting<br>Type of Course: Theory Course | L- T-P- C | 3-0-0-3 |
| Version No. | 2.0 | | |
| NCrF Level- | 5.0 | | |
| Course Pre-requisites | Fundamentals of Statistics | | |
| Co-requisites | NiL | | |
| Anti-requisites | CSEXXXX | | |
| Course Description | This course introduces the principles and techniques of time series analysis and forecasting for sequential data. It covers the identification of trend, seasonality, and cyclic patterns, smoothing methods, decomposition techniques, autoregressive models, ARIMA forecasting, model evaluation, and practical applications using Python-based analytical tools. The course enables learners to build forecasting models for business, finance, healthcare, manufacturing, and IoT applications. | | |
| Course Objective | The objective of this course is to familiarize learners with the concepts of Time Series Analysis and Forecasting, enabling them to analyze temporal data, develop forecasting models, evaluate prediction accuracy, and apply forecasting techniques to solve real-world problems through participative and experiential learning. | | |
| Course Outcomes | **On successful completion of the course the students shall be able to:**<br>**CO1:**Explain the fundamental concepts, characteristics, and components of time series data. [Level 2 - Understand]<br>**CO2**: Analyze trend, seasonal, and cyclical patterns in time series data using statistical techniques. [Level 4 – Analyze]<br>**CO3:**Apply smoothing and decomposition techniques for time series forecasting. [Level 3 – Apply]<br>**CO4:**Develop AR, MA, ARMA, and ARIMA models for forecasting real-world datasets. [Level 3 – Apply] [Level 3 – Apply]<br>**CO5:**Evaluate forecasting models using suitable performance metrics and recommend appropriate forecasting techniques for different applications. [Level 5 – Evaluate] | | |
| Course Content: | | | |
| Module 1 | Fundamentals of Time Series Analysis | Assessment: Assignment | 9 Sessions |
| Topics:<br>Introduction to Time Series<br>Characteristics of Time Series Data<br>Components of Time Series<br>Trend Analysis<br>Seasonal Variations<br>Cyclical and Irregular Variations<br>Time Series Visualization | | | |

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| Applications of Time Series Analysis | | | |
| Module 2 | Smoothing and Decomposition Techniques | Assessment :Demonstration | 9 Sessions |
| Topics:<br>Moving Average Methods<br>Weighted Moving Average<br>Simple Exponential Smoothing<br>Holt's Linear Trend Method<br>Holt-Winters Forecasting<br>Additive Decomposition<br>Multiplicative Decomposition<br>Seasonal Adjustment | | | |
| Module 3 | Time Series Models | Assessment : Assignment | 9 Sessions |
| Topics:<br>Stationarity<br>White Noise Process<br>Autocorrelation Function (ACF)<br>Partial Autocorrelation Function (PACF)<br>Autoregressive (AR) Models<br>Moving Average (MA) Models<br>ARMA Models<br>ARIMA Models | | | |
| Module 4 | Forecasting and Model Evaluation | Assessment :Quiz | 9 Sessions |
| Topics:<br>Forecasting using ARIMA<br>Forecast Accuracy Measures<br>Mean Absolute Error (MAE)<br>Mean Squared Error (MSE)<br>Root Mean Square Error (RMSE)<br>Mean Absolute Percentage Error (MAPE)<br>Model Validation<br>Residual Analysis | | | |
| Module 5 | Time Series Applications | Assessment :Demonstration | 9 Sessions |
| Topics:<br>Financial Time Series Forecasting<br>Sales and Demand Forecasting<br>Weather Forecasting<br>Healthcare Forecasting<br>IoT Time Series Analysis<br>Python-based Forecasting using Pandas and Statsmodels | | | |

Targeted Applications & Tools:

| **Tool** | **Application** |
|---|---|
| Python (Pandas) | Time Series Data Processing |
| Statsmodels | Forecasting Models (ARIMA, ETS) |
| Jupyter Notebook | Time Series Analysis |
| Microsoft Excel | Trend and Forecast Analysis |
| Power BI | Forecast Visualization and Dashboards |

Skill-Building Activities through Experiential Learning:

- Perform exploratory analysis on real-world time series datasets.
- Develop forecasting models using moving average, exponential smoothing, and ARIMA

techniques.

- Compare forecasting models using MAE, RMSE, and MAPE.
- Analyze financial, sales, weather, or IoT datasets to identify trends and seasonality.
- Implement a mini-project using Python to forecast future values from real-world datasets.

Text Book

**T1:**Rob J. Hyndman and George Athanasopoulos, Forecasting: Principles and Practice, 3rd Edition, OTexts, 2021.

**T2:**George E. P. Box, Gwilym M. Jenkins, Gregory C. Reinsel, Greta M. Ljung, Time Series Analysis: Forecasting and Control, 5th Edition, Wiley, 2015.

References

**R1:**Robert H. Shumway and David S. Stoffer, Time Series Analysis and Its Applications: With R Examples, 4th Edition, Springer, 2017.

**R2:**Douglas C. Montgomery, Cheryl L. Jennings, and Murat Kulahci, Introduction to Time Series Analysis and Forecasting, 2nd Edition, Wiley, 2015.

E-Resources/Web Resources

1. NPTEL – Time Series Analysis and Forecasting
2. https://presuniv.knimbus.com/user#/home
3. https://otexts.com/fpp3/
4. https://www.statsmodels.org/
5. https://pandas.pydata.org/
6. https://scikit-learn.org/
7. https://www.kaggle.com/datasets

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|---|---|---|---|
| Course Code: DSC4015 | Course Name: IoT Data Analytics<br>Type of Course:Discipline Elective Theory Course | L- T-P- C | 3-0-0-3 |
| Version No. | 2.0 | | |
| NCrF Level- | 5.0 | | |
| Course Pre-requisites | NIL | | |
| Co-requisites | NiL | | |
| Anti-requisites | CSEXXXX | | |
| Course Description | This course helps in understanding the context of analytics in IoT data. Strategies to collect IoT data in order to enable analytics. Skills learnt will enable to understand the tradeoffs in streaming and batch processing. Data science techniques such as machine learning, deep learning, and forecasting are applied on IoT data. This course also teaches how to implement machine learning methods and ARIMA forecasting on IoT data. Deep learning will be described along with a way to get started experimenting with it on AWS. | | |
| Course Objective | The objective of the course is to familiarize the learners with the concepts of IoT Data Analytics and attain EMPLOYABILITY SKILLS through Problem Solving Methodologies. | | |
| Course Outcomes | **On successful completion of the course the students shall be able to:**<br>**CO1:**Discuss the challenges of IoT Analytics. [Level 2 – Understand]<br>**CO2**: Apply strategies and techniques to collect IoT data. [Level 3 – Apply]<br>**CO3:**Apply data science techniques on IoT data [Level 4 – Apply] | | |
| Course Content: | | | |
| Module 1 | IoT analytics, challenges, devices and networking | Assessment: Data Analysis task | 12 Sessions |

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| Topics:<br>Defining IoT Analytics and Challenges Defining IoT Analytics. IoT analytics challenges, Core IoT Functional Stack, Functional blocks of an IoT ecosystem<br>IoT Devices and Networking Protocols IoT devices Networking basics IoT networking connectivity protocols<br>IoT networking data messaging protocols Message Queue Telemetry Transport (MQTT) Hyper-Text Transport Protocol (HTTP) Data Distribution Service (DDS) | | | |
| Module 2 | Data – Strategies, Techniques and Exploring IoT Data | Assessment :Analysis, Data Collection | 12 Sessions |
| Topics:<br>Collecting All That Data - Strategies and Techniques Designing data processing for analytics Applying big data technology to storage Apache Spark for data processing Exploring IoT Data Exploring. Data analytics tools | | | |
| Module 3 | Data Science for IoT Analytics | Assessment :Data analysis task | 13 Sessions |
| Topics:<br>Feature engineering with IoT data Validation methods Understanding the bias–variance trade off Comparing different models to find the best fit Random Forest models Gradient Boosting Machines Anomaly detection, Forecasting, scaling issues. | | | |
| Targeted Applications & Tools: | | | |
| Employment opportunities are available in Companies like Hexaware, Episteme, Randstad. Siemens, Accenture etc. as IoT Data Engineer<br><br>Tools<br>R<br>Python<br>Microsoft Azure Stream Analytics.<br>AWS IoT Analytics.<br>SAP Analytics Cloud.<br>Oracle Stream Analytics and Oracle Edge Analytics. | | | |
| Skill-Building Activities through Experiential Learning: | | | |
| Mini Project:<br><br>Develop a IoT application for real time data analysis of manufacturing sector. The automated IoT Analytics should aid in using real time data to watch out for certain patterns and send alerts to the concerned departments. It should enable smart manufacturing. | | | |
| Text Book<br>**T1**: "Analytics for the Internet of things (IoT)", Andrew Minteer, Packt, 2017 | | | |
| References<br>**R1:** WInternet of Things and Big Data Analytics for Smart Generation, Valentina E Balas, Springer | | | |
| E-Resources/Web Resources<br>1. https://presiuniv.knimbus.com/user#/home<br>2. https://www.orientsoftware.com/blog/iot-data-analytics/ | | | |

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|---|---|---|---|
| Course Code: DSC4016 | Course Name: Probabilistic graph Models Type of Course:Discipline Elective Theory Course | L- T-P- C | 3-0-0-3 |
| Version No. | 2.0 | | |
| NCrF Level- | 5.0 | | |
| Course Pre-requisites | NIL | | |
| Co-requisites | NiL | | |
| Anti-requisites | CSEXXXX | | |
| Course Description | Probabilistic graphical models are used to model stochasticity (uncertainty) in the world and are extremely popular in AI and machine learning. The course will cover two classes of graphical models: Bayesian belief networks (also called directed graphical models) and Markov Random Fields (undirected models). After introducing the two frameworks the course will focus on recent advances in inferences and learning with graphical models, including topics such as loopy belief propagation, variational approximations, conditional Markov random fields and others. | | |
| Course Objective | The objective of the course is to familiarize the learners with the concepts of Probabilistic graph Models and attain EMPLOYABILITY SKILLS through PARTICIPATIVE LEARNING techniques | | |
| Course Outcomes | **On successful completion of the course the students shall be able to:**<br><br>**CO1:**Apply key concepts of Statistics to solve problems [Level 3 – Apply]<br>**CO2**: Analyze the properties of distributions encoded by graphs . [Level 4 – Analyze]<br>**CO3:**Illustrate Inference in graphic models . [Level 2 – Understand]<br>**CO4:**Illustrate Learning in graphic models [Level 2 – Understand] | | |
| Course Content: | | | |
| Module 1 | Fundamentals of Probability and Graph Theory | Assessment: Understanding all standard probability distributions | 9 Sessions |
| Topics:<br>Fundamentals of Statistics and Probability, Conditional Probability, Conditional Independence, Joint Distributions, Baye's Theorem, Gaussians rule, Probability Distributions, Fundamentals of Graph Theory - Paths, Cliques, Sub-graphs, Cycles and Loops. | | | |
| Module 2 | Graphical Models | Assessment :Construction of Markov chain model for real time problems | 9 Sessions |
| Topics:<br>Directed Models: Bayesian Network; Undirected Models: Markov Random Fields; Parameterization of MRFs, Independencies, Duality and optimality, Non parametric Bayes hierarchical models. | | | |
| Module 3 | Inference in Graphical Models | Assessment :Study about some problems based on Monte Carlo method | 9 Sessions |
| Topics:<br>Inference in Graph Models, Variable Elimination; Belief Propagation, Sampling Methods: Markov Chain Monte Carlo, Convexity and optimization, Hidden Markov Model, Viterbi Algorithm. | | | |
| Module 4 | Learning in Graphical Models | Assessment :Applications of Naïve Bayes Classifier | 10 Sessions |
| Topics:<br>Learning in Graph Models, Maximum Likelihood Estimation, Naïve Bayes Classifier, Conditional Random Fields, constrained optimization problem | | | |

| Targeted Applications & Tools: |
|---|
| Targeted employment sector is to acquire knowledge to analyze the given problem to frame Probabilistic graphical models which are a powerful framework for representing complex domains using probability distributions, with numerous applications in machine learning, computer vision, natural language processing and computational biology.<br><br>Tools:<br>Python<br>HUGIN Tool for Learning Bayesian Networks<br>MATLAB Toolbox for Bayesian net |
| Skill-Building Activities through Experiential Learning: |
| Term Assignments:<br>Analysis and Application of Bayesian Network to real time problems<br>Understanding the given problem, analyze accordingly to apply Bayesian network and convert the problem in a Bayesian Network. The answering the required queries.<br>A short survey of the Monte Carlo Method<br>Study and analyze few realistic problems to apply Monte Carlo Technique to answer the solution of the problem.<br>A short survey of the Markov Chain & Hidden Markov Method<br>Study and analyze few realistic problems to convert into Markov chain & Hidden Markov to answer the required problem. |
| Text Book<br>**T1:** S. Lauritzen. Graphical Models. Oxford University Press, 1996.<br><br>**T2:** David J.C. Mackay. Information theory, inference, and learning algorithms. Cambridge, UK: Cambridge University Press 2003. |
| References<br>**R1 :**https://towardsdatascience.com/introduction-to-probabilistic-graphical-models-b8e0bf459812 |
| E-Resources/Web Resources<br>1. https://presiuniv.knimbus.com/user#/home<br>2. https://home.cs.colorado.edu/~mozer/Teaching/syllabi/ProbabilisticModels// |

| Course Code: DSC4017 | Course Name: Social Network Analysis<br>Type of Course:Discipline Elective Theory Course | L- T-P- C | 3-0-0-3 |
|---|---|---|---|
| Version No. | 2.0 | | |
| NCrF Level- | 5.0 | | |
| Course Pre-requisites | NIL | | |
| Co-requisites | NiL | | |
| Anti-requisites | CSEXXXX | | |

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|---|---|
| Course Description | The rapid growth of social media has given the mass consumers a powerful tool to create knowledge and propagate opinions. At the same time, social media has created an unprecedented opportunity for companies to engage real-time interactions with consumers. In addition, the size and richness of social media data has provided companies an unusually deep reservoir of consumer insights to transform the business and marketing operations.<br>The social media analytics course will enable students to grasp the analytics tools to leverage social media data. The course will introduce tools such as engagement analytics, sentiment analysis, topic modeling, social network analysis, identification of influencers and evaluation of social media strategy. |
| Course Objective | The objective of the course is to familiarize the learners with the concepts of Social Network Analysis and attain EMPLOYABILITY SKILLS through PROBLEM SOLVING techniques |
| Course Outcomes | **On successful completion of the course the students shall be able to:**<br><br>**CO1:**Interpret the social network landscape and appreciate the importance of analytics in business. [Level 2 – Understand]<br>**CO2**: Apply appropriate native analytics and measurement tools to analyze data in different social platforms. [Level 3 – Apply]<br>**CO3:**Use Natural Language Processing for efficient mining of web data . [Level 3 – Apply]<br>**CO4:**Demonstrate meaningful insights with actionable and strategic recommendations. [Level 3 – Apply] |

Course Content:

| | | | |
|---|---|---|---|
| Module 1 | Network Science | Assessment: Analysis | 9 Sessions |
| Topics:<br>Introduction to semantic web, limitation of current web, Central Measures, Community Analysis, CPM, Homophily and Triadic Closure, Affiliation Networks, Schelling model of Segregation, Current Social Media landscape, working environment, Getting analyzing and visualizing the data, Getting started with the toolset, Need for SMA, Applications of SMA in different areas. Connecting, Capturing and cleaning of Social Data. Social network analysis of social and behavioral sciences<br>APIs in nutshell, Introduction to authenticate techniques, Parsing API outputs, Basic cleaning techniques. Exploring GitHub's API, Analyzing GitHub Interest Graphs, Computing Graph Centrality Measures. | | | |
| Module 2 | Analyzing Social graphs and Sentiment | Assessment :Project Development | 10 Sessions |
| Topics:<br>Modeling and aggregating social network data, Exploring Facebook's Social Graph API, Open Graph Protocol, Analyzing Social Graph Connections, Mining your posts, Facebook Pages. | | | |
| Module 3 | Mining web pages | Assessment :Project Development | 11 Sessions |
| Topics:<br>Scraping, Parsing and Crawling the Web: BFS in Web Crawling, Discovering Semantics by Decoding Syntax: NLP Illustrated Step-by-Step, Sentence Detection in Human Language Data, Document Summarization, Entity-Centric Analysis: A Paradigm Shift, Summarizing Human Language Data, Quality of Analytics for Processing Human Language Data, trust models based on subjective logic<br>Campaigns and Consumer Reaction Analytics on YouTube: Structured and Unstructured, Scope and Process, Getting the data, Data pull, Data processing and Data analysis, Attack spectrum and counter measures. | | | |
| Module 4 | Recommender Systems and SEO | Assessment :Group Discussions | 8 Sessions |
| Topics:<br>Content-Based Recommendation and Collaborative Filtering, introduction to SEO, Keyword research Process, avoid negative SEO, Search Engines, Google PageRank, IBM HITS, | | | |
| Targeted Applications & Tools: | | | |

The applications of Social Media Analytics have been seen in industrial sector, sports and games, local governments services, tourism and hospitality services, politics, social issues, disaster management, community development issues, commerce and business applications, fashion industry, agricultural activities, online media, medical and health related services as well as supplier chain services.

Tools: Google Colab or JupyterNotebook(Anaconda).

Skill-Building Activities through Experiential Learning:

On completion of all Modules, students will be given a Mini Project to build a deep learning model for a given application.

Sample mini projects include:

Twitter Summaries

Twitter is famous for its character-limited posts. We can use this social media platform for an innovative summary-writing project. Consolidate the takeaways from a topic or reading discussed. Students should be able to understand the text, coherently organize the points and capture the central idea with 280 words, which is the character limit on Twitter.

Hashtag activism

Information and communication technologies provide a tremendous tool for spreading awareness and highlighting issues that may not be adequately represented in the mainstream media. Hashtag activism, in particular is concerned with driving social media traffic to oft-neglected topics. We can devise a project-based activity to teach our students about social justice, human rights, equality etc.

Text Book

**T1.**Mathew A. Russell, "Mining the Social Web", O'Reilly, 3rd Edition, 2019.

References

**R1 :**Marco Bonzanini, "Mastering Social Media Mining with Python", PacktPub, 2016.

E-Resources/Web Resources

i. https://presiuniv.knimbus.com/user#/home

ii. https://onlinecourses.nptel.ac.in/noc22_cs117/preview

| | | | |
|---|---|---|---|
| Course Code: DSC4018 | Course Name: Application of Probability theory in Computer Science<br>Type of Course:Discipline Elective Theory Course | L- T-P- C | 3-0-0-3 |
| Version No. | 2.0 | | |
| NCrF Level- | 5.0 | | |
| Course Pre-requisites | Fundamentals of Statistics | | |
| Co-requisites | NiL | | |
| Anti-requisites | CSEXXXX | | |
| Course Description | This course introduces the principles of probability theory and demonstrates their applications in computer science. It covers probability distributions, random variables, stochastic processes, probabilistic algorithms, Markov chains, Bayesian inference, reliability analysis, and machine learning applications. The course emphasizes analytical thinking and practical problem-solving using probability models in computing systems. | | |
| Course Objective | The objective of this course is to familiarize learners with the concepts of Probability Theory and its applications in Computer Science, enabling them to model uncertainty, analyze probabilistic systems, and solve real-world computing problems through participative and experiential learning. | | |

| | | | |
|---|---|---|---|
| Course Outcomes | **On successful completion of the course the students shall be able to:**<br><br>**CO1:**Explain the fundamental concepts of probability, random variables, and probability distributions. [Level 2 – Understand]<br>**CO2**: Analyze probabilistic models and stochastic processes used in computer science applications.. [Level 4 – Analyze]<br>**CO3:**Apply probability theory to solve problems in algorithms, computer networks, and reliability analysis. [Level 3 – Apply]<br>**CO4:**Apply Bayesian inference and Markov chain models for decision-making under uncertainty. [Level 3 – Apply]<br>CO5: Evaluate probabilistic approaches used in machine learning, data analytics, and artificial intelligence applications. [Level 5 – Evaluate] | | |
| Course Content: | | | |
| Module 1 | Fundamentals of Probability Theory | Assessment: Assignment | 9 Sessions |
| Topics:<br>Introduction to Probability<br>Sample Space and Events<br>Conditional Probability<br>Bayes' Theorem<br>Random Variables<br>Probability Distributions | | | |
| Module 2 | Discrete and Continuous Probability Models | Assessment :Demonstration | 9 Sessions |
| Topics:<br>Discrete Probability Distributions<br>Binomial Distribution<br>Poisson Distribution<br>Continuous Probability Distributions<br>Normal Distribution<br>Expectation and Variance | | | |
| Module 3 | Stochastic Processes and Markov Models | Assessment :Assignment | 9 Sessions |
| Topics:<br>Introduction to Stochastic Processes<br>Markov Chains<br>Transition Probability Matrix<br>Steady-State Probability<br>Random Walks<br>Applications in Computer Systems | | | |
| Module 4 | Probability Applications in Computer Science | Assessment :Quiz | 9 Sessions |
| Topics:<br>Randomized Algorithms<br>Probabilistic Analysis of Algorithms<br>Network Reliability<br>Queueing Concepts<br>Error Detection and Communication Systems<br>Reliability of Computing Systems | | | |
| Module 5 | Probability in AI and Data Science | Assessment :Quiz | 9 Sessions |
| Topics:<br>Bayesian Networks<br>Probabilistic Machine Learning | | | |

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|---|
| Hidden Markov Models<br>Probabilistic Graphical Models<br>Uncertainty in Artificial Intelligence<br>Case Studies and Applications |
| Targeted Applications & Tools: |
| Tool Application<br>Python (NumPy) Probability Computation<br>Python (SciPy) Statistical Distributions<br>Jupyter Notebook Probability Simulation<br>R Programming Statistical Analysis |
| Skill-Building Activities through Experiential Learning: |
| Simulate probability experiments using Python.<br>Analyze random processes in communication and networking.<br>Develop Bayesian models for decision-making problems.<br>Evaluate randomized algorithms through simulation.<br>Implement mini-projects involving probabilistic machine learning applications. |
| Text Book<br>**T1:**Dimitri P. Bertsekas and John N. Tsitsiklis, Introduction to Probability, 3rd Edition, Athena Scientific, 2021.<br>**T2:**Geoffrey Grimmett and David Stirzaker, Probability and Random Processes, 4th Edition, Oxford University Press, 2020. |
| References<br>**R1 :**Sheldon Ross, A First Course in Probability, 10th Edition, Pearson, 2019.<br>**R2**: Geoffrey Grimmett and David Stirzaker, Probability and Random Processes, 4th Edition, Oxford University Press, 2020. |
| E-Resources/Web Resources<br>**1.** https://presuniv.knimbus.com/user#/home<br>**2.** NPTEL – Probability and Statistics<br>**3.** https://ocw.mit.edu/courses/probability-and-statistics/<br>**4.** https://docs.scipy.org/<br>**5.** https://numpy.org/<br>**6.** https://www.kaggle.com/datasets |

| | | | |
|---|---|---|---|
| Course Code: DSC4019 | Course Name: Digital Image Processing<br>Type of Course:Integrated | L- T-P- C | 2-0-2-3 |
| Version No. | 1.0 | | |
| NCrF Level- | 5.0 | | |
| Course Pre-requisites | NIL | | |
| Co-requisites | Nil | | |
| Anti-requisites | CSEXXXX | | |
| Course Description | This course provides a comprehensive understanding of digital image processing techniques for data-driven image analysis and intelligent visual computing. Students will learn image enhancement, transformation, segmentation, feature extraction, pattern analysis, and image understanding using modern computational approaches. The laboratory component emphasizes practical implementation of image processing algorithms using Python and OpenCV for real-world applications in healthcare, remote sensing, smart cities, surveillance, and industrial analytics. | | |

<table>
<tr><td>Course Objective</td><td colspan="3">This course is designed to improve the learners 'EMPLOYABILITY SKILLS' by using EXPERIENTIAL LEARNING techniques.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">On successful completion of the course the students shall be able to:<br><br>CO1: Apply image acquisition, enhancement, and transformation techniques for digital image analysis. (Apply) [Level 3 - Apply]<br>CO2:Analyze image segmentation and feature extraction methods for visual data representation. (Analyze) [Level 3 – Apply]<br>CO3: Apply image classification and pattern recognition techniques using image features. (Apply) [Level 3 – Apply]<br>CO4: Evaluate image processing solutions for data science and intelligent vision applications. (Evaluate) [Level 3 – Apply]<br>CO5: Evaluate and compare different image processing algorithms and techniques based on accuracy, computational efficiency, robustness, and suitability for specific data science and intelligent vision applications. (Evaluate)</td></tr>
<tr><td colspan="4">Course Content:</td></tr>
<tr><td>Module 1</td><td>Digital Image Fundamentals and Enhancement</td><td>Assessment: Assignment</td><td>8 Sessions</td></tr>
<tr><td colspan="4">Digital Image Fundamentals, Image Acquisition Systems, Image Representation, Sampling and Quantization, Pixel Relationships, Histogram Processing, Contrast Enhancement, Intensity Transformations, Spatial Domain Filtering, Image Smoothing, Image Sharpening</td></tr>
<tr><td>Module 2</td><td>Probabilistic Models and Support Vector Machines</td><td>Assessment : Quiz /Assignment</td><td>7 Sessions</td></tr>
<tr><td colspan="4">Fourier Transform, Discrete Fourier Transform, Frequency Domain Representation, Frequency Domain Filtering, Image Restoration Concepts, Wavelet Transform Fundamentals, Multi-Resolution Analysis, Image Compression Principles.</td></tr>
<tr><td>Module 3</td><td>Image Segmentation and Feature Extraction</td><td>Assessment : Assignment</td><td>7 Sessions</td></tr>
<tr><td colspan="4">Threshold-Based Segmentation, Edge Detection Techniques, Region-Based Segmentation, Morphological Operations, Feature Extraction, Shape Features, Texture Features, Color Features, Feature Representation and Selection.</td></tr>
<tr><td>Module 4</td><td>Image Analytics and Intelligent Vision Applications</td><td>Assessment : Programming Assignment</td><td>8 Sessions</td></tr>
<tr><td colspan="4">Image Classification Concepts, Pattern Recognition Fundamentals, Object Detection Principles, Image Retrieval Systems, Medical Image Analytics, Remote Sensing Image Analysis, Surveillance Analytics, Deep Learning-Based Image Processing Overview, Emerging Trends in Visual Analytics.</td></tr>
<tr><td colspan="4">Lsit of Laboratory Tasks:<br><br>Module I: Image Enhancement (Weeks 1–4)<br><br>Week 1: Image Acquisition, Visualization, Color Space Conversion<br><br>Week 2: Histogram Analysis and Contrast Enhancement<br><br>Week 3: Spatial Filtering and Noise Removal<br><br>Week 4: Image Sharpening and Enhancement Performance Analysis<br><br>Module II: Transform and Frequency Analysis (Weeks 5–7)</td></tr>
</table>

**Week 5:** Fourier Transform and Frequency Spectrum Visualization

**Week 6:** Frequency Domain Filtering

**Week 7:** Image Compression and Wavelet-Based Analysis

**Module III: Segmentation and Feature Extraction (Weeks 8–11)**

**Week 8:** Threshold-Based Segmentation

**Week 9:** Edge Detection Techniques

**Week 10:** Morphological Operations and Region Analysis

**Week 11:** Texture, Shape and Color Feature Extraction

**Module IV: Image Analytics Applications (Weeks 12–15)**

**Week 12:** Image Classification using Feature-Based Machine Learning

**Week 13:** Object Detection and Recognition using Pre-trained Models

**Week 14:** Mini Project – Dataset Preparation and Model Development

**Week 15:** Mini Project – Testing, Evaluation and Demonstration

Targeted Applications & Tools:

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|---|---|
| Python (NumPy, pandas) | Core programming language and libraries used for data manipulation, cleaning, and preprocessing throughout the course. |
| OpenCV (cv2) | Primary library for implementing image filtering, edge detection, morphological operations, segmentation, feature extraction, and real-time image processing applications. |
| TensorFlow &Keras | Building and training neural networks such as perceptrons and multi-layer perceptrons (MLPs), and implementing backpropagation efficiently. |
| Matplotlib & Seaborn | Visualizing data distributions, decision boundaries, model performance (e.g., confusion matrix, ROC curves), and clustering outcomes. |
| 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:

- **Image Enhancement and Contrast Analysis**
  Learners experiment with histogram equalization, intensity transformations, and spatial filtering techniques (smoothing, sharpening) on real-world images. Through laboratory assignments, students compare enhancement performance across different image types and analyze noise removal effectiveness.
- · **Frequency Domain Filtering and Wavelet Analysis**
  Using Fourier Transform and Wavelet Transform, students implement frequency domain filtering for image restoration and compression. They gain practical experience in visualizing frequency spectra, applying low-pass/high-pass filters, and analyzing multi-resolution image representations.
- · **Segmentation and Feature Extraction for Pattern Recognition**
  Through threshold-based segmentation, edge detection (Canny, Sobel), and morphological operations, learners segment real-world images and extract shape, texture, and color features. They apply feature selection methods and evaluate segmentation quality using metrics like Precision, Recall, and IoU (Intersection over Union).
- · **Mini Project – Intelligent Vision Application Development**

| | |
|---|---|
| | Students develop a complete image analytics pipeline from dataset preparation to model deployment. They implement image classification or object detection using pre-trained models (e.g., YOLO, VGG, ResNet), test on real-world datasets, and demonstrate applications in healthcare, remote sensing, or surveillance domains. |
| Text Book<br>T1: Rafael C. Gonzalez, Richard E. Woods, **Digital Image Processing**, 4th Edition, Pearson Education, 2018.<br>T2: Anil K. Jain, **Fundamentals of Digital Image Processing**, Pearson Education, 2015. | |
| References<br>R1: Wilhelm Burger, Mark J. Burge, **Digital Image Processing: An Algorithmic Introduction Using Java**, 3rd Edition, Springer, 2022.<br>R2: Scott E. Umbaugh, **Digital Image Processing and Analysis**, 3rd Edition, CRC Press, 2018.<br>R3: Milan Sonka, Vaclav Hlavac, Roger Boyle, **Image Processing, Analysis and Machine Vision**, 5th Edition, Cengage Learning, 2019. | |

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|---|---|---|---|
| **Course Code:** **DSC4020** | **Course Title:** **Data Mining and Pattern Recognition**<br>**Type of Course:** **Discipline Elective-II** | **L-P-C** | 2-0-2-3 |
| **Version No.** | 1.1 | | |
| **Course Pre-requisites** | MAT1001 – Linear Algebra and Calculus | | |
| **Anti-requisites** | NIL | | |
| **Course Description** | This course introduces an extensive study on data pre-processing and classification algorithms. This course will help the students in selecting suitable data mining algorithms to solve the real time problems, and to discover frequent item sets by association rule algorithm. The course emphasizes on the recent trends in spatial mining. It interacts the students to study the different Clustering algorithms. | | |
| **Course Objective** | This course is designed to improve the learners' EMPLOYABILITY SKILLS by using PROBLEMSOLVING Methodologies. | | |
| **Course Out Comes** | On successful completion of the course the students shall be able to:<br>**CO1**: **Describe** the basic concepts and issues involved in Data Mining. [Level 2 – Understand]<br>**CO2**: **Discuss**different preprocessing techniques on Data Analysis. [Level 4 – Analyze]<br>**CO3**:**Discover** frequent item sets by using Association rule algorithms. [Level 3 – Apply]<br>**CO4**: **Apply** different Classification algorithms in data mining[Level 3 – Apply]<br>**CO5**: **Apply** the various clustering techniques.[Application][Level 3 – Apply] | | |
| **Course Content:** | | | |
| **Module 1** | Introduction to Data Mining | Assignment: Data Collection | **6 Sessions** |

| | | | |
|---|---|---|---|
| Topics:Introduction to Data mining: Definition, KDD, Challenges, Data Mining Tasks - Data Mining Goals– Stages of the Data Mining Process–Data Mining Techniques– Applications – Major Issues in Data mining. | | | |
| **Module 2** | Data Preprocessing | Quiz<br>Problem Solving | **7 Sessions** |
| Topics: Types of data – Data Quality – Data Pre-processing Techniques – Similarity and Dissimilarity measures. | | | |
| **Module 3** | Data Mining – Frequent Patterns / Classification | Assignment<br>Problem Solving | **7 Sessions** |
| Topics:<br>Motivation and terminology: Basic idea - Item sets – Generating frequent item sets and rules efficiently – Apriori Algorithm – FP Growth - Decision tree Induction – Bayes classification methods – Rule based classification – Classification by Back Propagation.<br><br>**Assignment:** Apply the Apriori algorithms for finding the frequent Item set in the given TDB.<br><br>1) Find the Gini Index value of the attributes.<br>2) Classify the given model using Decision tree algorithm. | | | |
| **Module 4** | Cluster Analysis Methods and Pattern Mining | Assignment<br>Problem Solving | **8 Sessions** |
| Topics: Cluster Analysis-Partitioning methods – Hierarchical methods – Basics of Density based method – Pattern mining: A Road Map<br><br>**Assignment:**<br><br>1) Cluster the objects using Cluster algorithms.<br>2) Problem for Cluster validation.<br>3) Apply the Process of data mining in the Employee database. | | | |
| **Module 5** | Foundations of Pattern Recognition | Assignment<br>Problem Solving | **8 Sessions** |
| Topics: Introduction to Pattern Recognition - Pattern Recognition Systems - Design Cycle of Pattern Recognition - Pattern Representation and Feature Extraction - Feature Selection Methods --- Curse of Dimensionality - Similarity and Distance Measures.<br><br>**Mini Project Topics in Pattern Recognition:**<br>□ Stock Market Prediction using Deep Learning and Pattern Recognition<br>□ Medical Disease Detection using CNN<br>□ Face Mask Detection using Computer Vision<br>□ Handwritten Character Recognition<br>□ Emotion Recognition from Facial Expressions<br>□ BrainTumor Classification using MRI Images<br>□ Intrusion Detection using Pattern Recognition Techniques<br>□ Crop Disease Detection using Image Analysis<br>□ Speech Emotion Recognition<br>□ Fake News Detection using NLP and Pattern Recognition | | | |
| Targeted Applications & Tools: | | | |
| **ython (Scikit-learn)** Data Mining Algorithms, Classification, Clustering, Pattern Recognition<br><br>**WEKA** Data Preprocessing, Classification, Association Rule Mining, Clustering | | | |

**RapidMiner** Visual Data Mining Workflow, Predictive Analytics

Skill-Building Activities through Experiential Learning:

**Assignments**

1. From the dataset given, find the Entropy, Gain value of the attributes and also draw the decision tree using entropy for the given dataset.

2. Transactional Data Base, D given below which contains set of items find the frequent item set using the Apriori Algorithm and generate the Association Rules. Minimum Support count is 2%. Minimum confidence is 60%.

| $T_{id}$ | Items |
|---|---|
| 10 | 1, 3, 4 |
| 20 | 2, 3, 5 |
| 30 | 1, 2, 3, 5 |
| 40 | 2, 5 |

**Text Book:**

T1. Jiawei Han, Micheline Kamber and Jian Pei, "Data Mining: Concepts and Techniques", Morgan Kaufmann Publishers, Third Edition, 2012.

T2. Richard O. Duda, Peter E. Hart, David G. Stork, *Pattern Classification*, 2nd Edition, Wiley.

**References:**

R1. Tan P. N, Steinbach M and Kumar V, "Introduction to Data Mining", Pearson Education, 2016.

R2. G K Gupta, "Introduction to Data Mining with Case Studies", Third Edition, PHI, 2014.

R3. Christopher M. Bishop, *Pattern Recognition and Machine Learning*, Springer.

R4. Sergios Theodoridis and Konstantinos Koutroumbas, *Pattern Recognition*, 5th Edition, Academic Press.

**Weblinks:**

https://onlinecourses.swayam2.ac.in/cec20_cs12/preview

https://puniversity.informaticsglobal.com:2284/ehost/detail/detail?vid=7&sid=e2d7362a-fd30-49a9-8f03-93e963521dbd%40redis&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#AN=377411&db=nlebk

(or)

http://182.72.188.195/cgi-bin/koha/opac-detail.pl?biblionumber=4001&query_desc=ti%2Cwrdl%3A%20Data%20Mining%3A%20Concepts%20and%20Techniques

| | | | |
|---|---|---|---|
| **Course Code:** **DSC4021** | **Course Title:** **Graph Analytics and Network Science**<br>**Type of Course:** **Discipline Elective-II** | **L-P-C** | 3-0-0-3 |
| **Version No.** | 1.1 | | |
| **Course Pre-requisites** | Data Structures<br>Discrete Mathematics | | |
| **Anti-requisites** | NIL | | |
| **Course Description** | This course describes the fundamental concepts of graph analytics and network science for modeling and analyzing complex interconnected systems. It introduces graph theory, graph algorithms, network analysis, community detection, graph mining, and graph-based machine learning. The course also covers applications of graph analytics in social networks, recommendation systems, biological networks, cybersecurity, and knowledge graphs using modern graph analytics tools. | | |
| **Course Objective** | The objective of the course is to familiarize the learners with the concepts of Graph Analytics and Network Science and attain analytical and problem-solving skills through participative learning techniques. | | |
| **Course Out Comes** | On successful completion of the course the students shall be able to:<br>**CO1:** Describe the fundamental concepts of graph theory, graph representations, and network models. [Level 2 – Understand]<br>**CO2:** Analyze graph structures and network properties using graph metrics and centrality measures. [Level 4 – Analyze]<br>**CO3:** Apply graph traversal and graph algorithms to solve network analysis problems. [Level 3 – Apply**]**<br>**CO4:** Apply graph mining and community detection techniques to identify patterns in complex networks. [Level 3 – Apply**]**<br>**CO5:** Evaluate graph analytics solutions for real-world applications such as social networks, cybersecurity, recommendation systems, and biological networks. [Level 5 – Evaluate] | | |
| **Course Content:** | | | |
| **Module 1** | Fundamentals of Graph Analytics | Assignment:<br>Data Collection | **9 Sessions** |
| Topics:Introduction to Graph Analytics; Graph Terminology; Types of Graphs; Graph Representation; Directed and Undirected Graphs; Weighted Graphs; Applications of Graph Analytics. | | | |
| **Module 2** | Graph Algorithms | Quiz<br>Problem Solving | **9 Sessions** |
| Topics: Graph Traversal; BFS; DFS; Shortest Path Algorithms; Minimum Spanning Tree; Connectivity Analysis. | | | |
| **Module 3** | Network Analysis | Assignment<br>Problem Solving | **9 Sessions** |
| Topics:<br>Degree Distribution; Network Density; Clustering Coefficient; Centrality Measures; PageRank Algorithm; Small World Networks. | | | |
| **Module 4** | Graph Mining and Machine Learning | Assignment<br>Problem Solving | **9 Sessions** |
| Topics: Frequent Subgraph Mining; Community Detection; Link Prediction; Graph Embedding; Introduction to Graph Neural Networks; Graph-Based Machine Learning. | | | |

| **Module 5** | Applications of Graph Analytics | Assignment<br>Problem Solving | **9 Sessions** |
|---|---|---|---|
| Social Network Analysis; Recommendation Systems; Fraud Detection; Cybersecurity Networks; Biological Networks; Knowledge Graphs | | | |
| Targeted Applications & Tools: | | | |
| **Tool** **Application**<br>Python (NetworkX) Graph Creation and Network Analysis<br>Neo4j Graph Database Management and Querying<br>Gephi Network Visualization and Community Detection<br>Python (igraph) Large-scale Graph Analysis<br>Apache Spark GraphX Distributed Graph Processing<br>Jupyter Notebook / Google Colab Graph Algorithm Implementation and Visualization | | | |
| Skill-Building Activities through Experiential Learning: | | | |
| • Construct and visualize graphs.<br>• Implement BFS, DFS, shortest path and PageRank.<br>• Analyze social network datasets.<br>• Perform community detection.<br>• Develop a mini-project using real-world datasets | | | |
| **Text Book:**<br>**T1.**Maarten van Steen, Graph Theory and Complex Networks: An Introduction, 3rd Ed., Springer, 2019.<br>**T2.**Mark Newman, Networks: An Introduction, 2nd Ed., Oxford University Press, 2018. | | | |
| **References:**<br>R1. Charu C. Aggarwal, Data Mining: The Textbook, Springer International Publishing, 1st Edition, 2015.<br>R2. Reza Zafarani, Mohammad Ali Abbasi, and Huan Liu, Social Media Mining: An Introduction, Cambridge University Press, 1st Edition, 2014.<br>**Weblinks:**<br>• https://presuniv.knimbus.com/user#/home<br>• https://networkx.org/documentation/stable/<br>• https://neo4j.com/docs/<br>• https://gephi.org/users/<br>• https://igraph.org/ | | | |

| Course Code: DSC4022 | Course Name: Geospatial Data Science<br>Type of Course: Theory Course | L- T-P- C | 3-0-0-3 |
|---|---|---|---|
| Version No. | 2.0 | | |
| NCrF Level- | 5.0 | | |
| Course Pre-requisites | Fundamentals of Statistics | | |
| Co-requisites | NiL | | |
| Anti-requisites | CSEXXXX | | |

<table>
<tr><td>Course Description</td><td colspan="3">This course introduces the concepts and techniques of Geospatial Data Science for analyzing spatial and geographic data. It covers GIS, spatial data models, coordinate systems, remote sensing, spatial databases, spatial analysis, visualization, and machine learning techniques for geospatial applications.</td></tr>
<tr><td>Course Objective</td><td colspan="3">The objective of this course is to familiarize learners with the concepts of Geospatial Data Science, enabling them to acquire, manage, analyze, visualize, and interpret geospatial data using modern GIS tools.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">On successful completion of the course the students shall be able to:<br><br>CO1: Explain the fundamental concepts of geospatial data, GIS, coordinate systems, and spatial data models. [Level 2 – Understand]<br>CO2:Analyze spatial datasets using GIS techniques and spatial analysis methods. [Level 4 – Analyze]<br>CO3: Apply geospatial data processing and visualization techniques using GIS software. [Level 3 – Apply]<br>CO4: Apply spatial analysis and remote sensing techniques to solve real-world geospatial problems. [Level 3 – Apply]</td></tr>
<tr><td colspan="4">Course Content:</td></tr>
<tr><td>Module 1</td><td>Fundamentals of Geospatial Data Science</td><td>Assessment: Assignment</td><td>9 Sessions</td></tr>
<tr><td colspan="4">Topics:<ul><li>Introduction to Geospatial Data Science</li><li>Spatial and Non-Spatial Data</li><li>GIS Fundamentals</li><li>Coordinate Systems</li><li>Map Projections</li></ul>Applications of Geospatial Data Science</td></tr>
<tr><td>Module 2</td><td>Spatial Data Models and GIS</td><td>Assessment :Demonstration</td><td>9 Sessions</td></tr>
<tr><td colspan="4">Topics:<ul><li>Vector Data Model</li><li>Raster Data Model</li><li>Spatial Databases</li><li>Data Acquisition</li><li>Data Preprocessing</li><li>Spatial Data Quality</li></ul></td></tr>
<tr><td>Module 3</td><td>Spatial Analysis and Remote Sensing</td><td>Assessment : Assignment</td><td>9 Sessions</td></tr>
<tr><td colspan="4">Topics:<ul><li>Spatial Query Processing</li><li>Buffer Analysis</li><li>Overlay Analysis</li><li>Network Analysis</li><li>Introduction to Remote Sensing</li><li>Satellite Image Processing</li></ul></td></tr>
<tr><td>Module 4</td><td>Geospatial Visualization and Machine Learning</td><td>Assessment :Quiz and Demonstration</td><td>9 Sessions</td></tr>
<tr><td colspan="4">Topics:<ul><li>Cartographic Visualization</li><li>Thematic Mapping</li><li>Spatial Statistics</li><li>Spatial Clustering</li><li>Machine Learning for Geospatial Data</li><li>Predictive Spatial Analytics</li></ul></td></tr>
</table>

| Module 5 | Applications of Geospatial Data Science | Assessment :Miniproject Presentation | 9 Sessions |
|---|---|---|---|

Topics :
Smart City Applications
Transportation Analytics
Precision Agriculture
Disaster Management
Environmental Monitoring
Location-Based Services

Targeted Applications & Tools:

| | |
|---|---|
| QGIS | Spatial Data Analysis and GIS Mapping |
| ArcGIS Pro | Advanced Geospatial Analysis |
| Python (GeoPandas) | Geospatial Data Processing |
| Python (Rasterio& Shapely) | Raster and Vector Data Analysis |

Skill-Building Activities through Experiential Learning:

- Smart City Applications
- Transportation Analytics
- Precision Agriculture
- Disaster Management
- Environmental Monitoring
- Location-Based Services
-

Text Book

**T1:** Paul A. Longley, Michael F. Goodchild, David J. Maguire, and David W. Rhind, Geographic Information Science and Systems, 5th Edition, Wiley, 2021.

**T2:** Jillian M. Aversa, Python for Geospatial Data Analysis, Packt Publishing, 2023..

References

**R1:** Michael de Smith, Michael Goodchild, and Paul Longley, Geospatial Analysis: A Comprehensive Guide, 7th Edition, 2024.

**R2:** Ian Heywood, Sarah Cornelius, and Steve Carver, An Introduction to Geographical Information Systems, 5th Edition, Pearson, 2019..

E-Resources/Web Resources

- https://presuniv.knimbus.com/user#/home
- NPTEL – Geographic Information Systems
- https://docs.qgis.org/
- https://developers.arcgis.com/
- https://geopandas.org/
- https://earthengine.google.com/

| Course Code: DSC4023 | Course Name: Marketing and Consumer Analytics<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 | Fundamentals of Statistics | | |
| Co-requisites | NiL | | |
| Anti-requisites | CSEXXXX | | |

| | |
|---|---|
| Course Description | This course introduces the concepts and techniques of Marketing and Consumer Analytics for data-driven business decision-making. It covers customer segmentation, consumer behavior, market basket analysis, customer lifetime value, predictive marketing, digital marketing analytics, sentiment analysis, and marketing performance measurement. The course emphasizes analytical techniques for understanding customer preferences and optimizing marketing strategies using data analytics tools. |
| Course Objective | The objective of this course is to familiarize learners with the concepts of Marketing and Consumer Analytics, enabling them to analyze consumer behavior, evaluate marketing performance, and develop data-driven marketing strategies through participative and experiential learning. |
| Course Outcomes | **On successful completion of the course the students shall be able to:**<br>**CO1:** Explain the fundamental concepts of marketing analytics, consumer behavior, and customer data analysis. [Level 2 – Understand]<br><br>**CO2:** Analyze customer data to identify consumer preferences, market trends, and purchasing behavior. [Level 4 – Analyze]<br><br>**CO3:** Apply analytical techniques for customer segmentation, market basket analysis, and predictive marketing. [Level 3 – Apply]<br><br>**CO4:** Apply digital marketing analytics and sentiment analysis techniques to evaluate marketing effectiveness. [Level 3 – Apply]<br><br>**CO5:** Evaluate marketing strategies and customer engagement using business analytics techniques. [Level 5 – Evaluate] |

Course Content:

| | | | |
|---|---|---|---|
| Module 1 | Fundamentals of Marketing Analytics | Assessment: Assignment | 9 Sessions |

Topics:
- Introduction to Marketing Analytics
- Consumer Behavior
- Marketing Data Sources
- Customer Data Collection
- Marketing Metrics
- Applications of Marketing Analytics

| | | | |
|---|---|---|---|
| Module 2 | Customer Analytics | Assessment :Demonstration | 9 Sessions |

Topics:
- Customer Segmentation
- Customer Profiling
- Market Basket Analysis
- Customer Lifetime Value (CLV)
- RFM Analysis
- Customer Retention Analytics

| | | | |
|---|---|---|---|
| Module 3 | Predictive Marketing Analytics | Assessment : Assignment | 9 Sessions |

Topics:
- Predictive Analytics
- Demand Forecasting
- Churn Prediction
- Recommendation Systems
- Pricing Analytics
- Sales Analytics

| Module 4 | Digital Marketing Analytics | Assessment :Quiz and Demonstration | 9 Sessions |
|---|---|---|---|
| Topics:<br>Web Analytics<br>Social Media Analytics<br>Sentiment Analysis<br>Campaign Performance Analysis<br>Search Engine Analytics<br>Marketing Dashboards | | | |
| Module 5 | Applications of Consumer Analytics | Assessment :Miniproject Presentation | 9 Sessions |
| Topics :<br>Retail Analytics<br>E-Commerce Analytics<br>Customer Experience Analytics<br>Brand Performance Analysis<br>Marketing ROI<br>Case Studies and Business Applications | | | |

| Targeted Applications & Tools: | |
|---|---|
| Power BI | Marketing Dashboard and KPI Visualization |
| Tableau | Consumer Analytics Visualization |
| Google Analytics | Website Traffic and Campaign Analytics |
| Jupyter Notebook | Marketing Analytics Model Development |

Skill-Building Activities through Experiential Learning:

- Analyze customer purchasing behavior using real-world datasets.
- Perform customer segmentation using clustering techniques.
- Develop predictive models for customer churn and sales forecasting.
- Analyze website traffic and digital marketing campaign performance.
- Design an interactive marketing dashboard using Power BI or Tableau.
- Implement a mini-project on consumer analytics for retail or e-commerce.

Text Book

**T1:** Stephan Sorger, Marketing Analytics: Strategic Models and Metrics, 2nd Edition, Mercury Learning and Information, 2021.

**T2:** Wayne L. Winston, Marketing Analytics: Data-Driven Techniques with Microsoft Excel, Wiley, 2020.

References

**R1:** Katie Delahaye Paine, Measure What Matters: Online Tools for Understanding Customers, Social Media, Engagement, and Key Relationships, Wiley, 2019.

**R2:** Kevin Gray and Eric V. Larson, Practical Predictive Analytics and Decisioning Systems for Medicine, Elsevier, 2019. (Predictive analytics concepts applicable to marketing.)

E-Resources/Web Resources

- https://presuniv.knimbus.com/user#/home
- NPTEL – Marketing Analytics
- https://analytics.google.com/
- https://powerbi.microsoft.com/
- https://public.tableau.com/

| Course Code: DSC4024 | Course Name: Multimodal Learning<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 | Fundamentals of Machine Learning | | |

| | | | |
|---|---|---|---|
| Co-requisites | NiL | | |
| Anti-requisites | CSEXXXX | | |
| Course Description | This course introduces the concepts and techniques of Multimodal Learning for integrating and analyzing information from multiple data modalities such as text, images, audio, and video. It covers multimodal data representation, feature fusion, deep learning architectures, transformers, vision-language models, multimodal large language models, and real-world applications. The course emphasizes designing intelligent systems capable of understanding and reasoning across heterogeneous data sources. | | |
| Course Objective | The objective of this course is to familiarize learners with the concepts of Multimodal Learning, enabling them to integrate, analyze, and model multiple data modalities using deep learning techniques and modern AI frameworks through participative and experiential learning. | | |
| Course Outcomes | **On successful completion of the course the students shall be able to:**<br>**CO1:** Explain the fundamental concepts of multimodal data, feature representation, and multimodal learning architectures.**[Level 2 – Understand]**<br>**CO2:** Analyze different multimodal fusion strategies and deep learning models for multimodal data analysis**.** **[Level 4 – Analyze]**<br>**CO3:** Apply multimodal learning techniques for integrating text, image, audio, and video data.<br>**[Level 3 – Apply]**<br>**CO4:** Apply transformer-based and vision-language models to solve multimodal AI problems.<br>**[Level 3 – Apply]**<br>**CO5:** Evaluate multimodal learning solutions for applications such as healthcare, autonomous systems, multimedia retrieval, and conversational AI.**[Level 5 – Evaluate]** | | |
| Course Content: | | | |
| Module 1 | Fundamentals of Multimodal Learning | Assessment: Assignment | 9 Sessions |
| Topics:<br>Introduction to Multimodal Learning<br>Types of Multimodal Data<br>Data Representation<br>Feature Extraction<br>Multimodal Datasets<br>Applications of Multimodal Learning | | | |
| Module 2 | Multimodal Data Fusion | Assessment :Demonstration | 9 Sessions |
| Topics:<br>Feature-Level Fusion<br>Decision-Level Fusion<br>Intermediate Fusion<br>Data Alignment<br>Representation Learning<br>Fusion Challenges | | | |
| Module 3 | Deep Learning for Multimodal Systems | Assessment : Assignment | 9 Sessions |
| Topics:<br>Neural Networks for Multimodal Learning<br>Convolutional Neural Networks<br>Recurrent Neural Networks<br>Attention Mechanisms | | | |

| | | | |
|---|---|---|---|
| Transformer Models<br>Vision-Language Models | | | |
| Module 4 | Multimodal AI Models | Assessment :Quiz and Demonstration | 9 Sessions |
| Topics:<br>Multimodal Transformers<br>Contrastive Learning<br>Cross-Modal Retrieval<br>Image Captioning<br>Visual Question Answering<br>Large Multimodal Models | | | |
| Module 5 | Applications of Multimodal Learning | Assessment :Miniproject Presentation | 9 Sessions |
| Topics :<br>Healthcare Analytics<br>Autonomous Vehicles<br>Multimedia Search<br>Human-Computer Interaction<br>Conversational AI<br>Smart Surveillance Systems | | | |

Targeted Applications & Tools:

| | |
|---|---|
| TensorFlow/Keras | Multimodal Neural Networks |
| Hugging Face Transformers | Vision-Language Models and Transformers |
| OpenCV | Image and Video Processing |
| Jupyter Notebook / Google Colab | Model Development and Experimentation |

Skill-Building Activities through Experiential Learning:

- Develop multimodal datasets by combining text, image, and audio data.
- Implement feature fusion techniques for multimodal classification.
- Build transformer-based vision-language models using Python.
- Perform image captioning and visual question answering experiments.
- Develop a mini-project using multimodal learning for healthcare, multimedia retrieval, or conversational AI..

Text Book

**T1:** Louis-Philippe Morency, Paul Pu Liang, and Amir Zadeh, Multimodal Machine Learning: Theory and Applications, MIT Press, 2023.

**T2: Y**ao-Hung Hubert Tsai, Shao-Yen Tseng, and Louis-Philippe Morency, Multimodal Deep Learning, Morgan & Claypool Publishers, 2023.

References

**R1:** Ashish Vaswani et al., Attention Is All You Need, NeurIPS, 2017.

**R2:** Alec Radford et al., Learning Transferable Visual Models From Natural Language Supervision (CLIP), OpenAI, 2021.

E-Resources/Web Resources

- NPTEL – Deep Learning
- https://huggingface.co/docs
- https://pytorch.org/tutorials/
- https://www.tensorflow.org/tutorials
- https://opencv.org/

| | | | |
|---|---|---|---|
| Course Code: DSC4025 | Course Name: Intelligent Decision Support Systems<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 | Fundamentals of Machine Learning | | |
| Co-requisites | NiL | | |
| Anti-requisites | CSEXXXX | | |
| Course Description | This course introduces the concepts and techniques of Intelligent Decision Support Systems (IDSS) for data-driven decision-making. It covers decision support system architecture, knowledge-based systems, expert systems, business intelligence, machine learning techniques, predictive analytics, optimization methods, and intelligent decision models. The course emphasizes the application of AI-driven decision support systems in healthcare, finance, manufacturing, supply chain, and smart governance. | | |
| Course Objective | The objective of this course is to familiarize learners with the concepts of Intelligent Decision Support Systems, enabling them to design, develop, and evaluate intelligent systems that support effective decision-making using artificial intelligence, machine learning, and business analytics techniques through participative and experiential learning. | | |
| Course Outcomes | **On successful completion of the course the students shall be able to:**<br>**CO1:** Explain the fundamental concepts, architecture, and components of Intelligent Decision Support Systems.<br>[Level 2 – Understand]<br><br>**CO2:** Analyze decision-making processes using business intelligence and knowledge-based techniques.<br>[Level 4 – Analyze]<br><br>**CO3:** Apply machine learning and predictive analytics techniques to support intelligent decision-making.<br>[Level 3 – Apply]<br><br>**CO4:** Apply optimization and expert system techniques to develop intelligent decision support solutions.<br>[Level 3 – Apply]<br><br>**CO5:** Evaluate intelligent decision support systems for applications in healthcare, finance, manufacturing, and smart governance.<br>[Level 5 – Evaluate] | | |
| Course Content: | | | |
| Module 1 | Fundamentals of Intelligent Decision Support Systems | Assessment: Assignment | 9 Sessions |
| Topics:<br>Introduction to Decision Support Systems<br>Components of DSS<br>Decision-Making Process<br>Types of Decision Support Systems<br>Knowledge-Based Systems<br>Applications of IDSS | | | |
| Module 2 | Knowledge | Assessment :Demonstration | 9 Sessions |

| | | | |
|---|---|---|---|
| | Representation and Expert Systems | | |
| Topics:<br>Knowledge Representation<br>Rule-Based Systems<br>Expert Systems<br>Inference Engine<br>Knowledge Acquisition<br>Reasoning Techniques | | | |
| Module 3 | Machine Learning for Decision Support | Assessment : Assignment | 9 Sessions |
| Topics:<br>Predictive Analytics<br>Classification Techniques<br>Regression Models<br>Clustering for Decision Support<br>Recommendation Systems<br>Model Evaluation | | | |
| Module 4 | Business Intelligence and Optimization | Assessment :Quiz and Demonstration | 9 Sessions |
| Topics:<br>Business Intelligence<br>Data Warehousing<br>OLAP<br>Decision Trees<br>Optimization Techniques<br>Multi-Criteria Decision Making | | | |
| Module 5 | Applications of Intelligent Decision Support Systems | Assessment :Miniproject Presentation | 9 Sessions |
| Topics :<br>Healthcare Decision Support<br>Financial Decision Support<br>Supply Chain Analytics<br>Manufacturing Analytics<br>Smart Governance<br>Case Studies and Applications | | | |

Targeted Applications & Tools:

| | |
|---|---|
| Power BI | Business Intelligence Dashboards |
| Tableau | Data Visualization and Decision Analytics |
| RapidMiner | Machine Learning and Predictive Modeling |
| Jupyter Notebook | Intelligent Decision Model Development |

Skill-Building Activities through Experiential Learning:

- Develop decision support models using real-world datasets.
- Build predictive analytics models for business decision-making.
- Design expert systems using rule-based approaches.
- Create interactive dashboards for business intelligence.
- Implement a mini-project on intelligent decision support for healthcare, finance, or supply chain management.

Text Book

**T1:** Efraim Turban, Ramesh Sharda, and Dursun Delen, Decision Support and Business Intelligence Systems, 11th Edition, Pearson, 2022.

**T2:** Vicki L. Sauter, Decision Support Systems for Business Intelligence, 3rd Edition, Wiley, 2020.

| References |
|---|
| **R1:** Daniel J. Power, Decision Support, Analytics, and Business Intelligence, 3rd Edition, Business Expert Press, 2020.<br>**R2:** Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 4th Edition, Pearson, 2021.. |
| E-Resources/Web Resources<br>• NPTEL – Business Intelligence and Analytics<br>• https://scikit-learn.org/<br>• https://powerbi.microsoft.com/<br>• https://www.tableau.com/learn<br>• https://rapidminer.com/ |

| | | | |
|---|---|---|---|
| Course Code: AIE4504 | Course Name: Natural Language Processing Techniques<br>Type of Course: Integrated Course | L- T-P- C | 2-0-2-3 |
| Version No. | 1.0 | | |
| NCrF Level- | 5.0 | | |
| Course Pre-requisites | NIL | | |
| Co-requisites | NiL | | |
| Anti-requisites | AIE4002 | | |
| Course Description | This course introduces a basics of Natural Language Processing methods with specific emphasis on modern applications. The course will cover pre-processing techniques of textual data like stemming, lemmatization, tokenization etc. Different word Vectorization Techniques like Bag of Words, TF-iDF etc. followed by basics of Probability for building language models. Basics of Neural Network, LSTM Recurrent Neural Network, Applications of NLP like Information Extraction, Emotion Extraction from text, sentiment analysis etc. | | |
| Course Objective | •To familiarize the learners with the concepts of Natural Language Processing<br>•Attain skill development through Experiential Learning techniques | | |
| Course Outcomes | **On successful completion of the course the students shall be able to:**<br>**CO1:** Understanding the fundamentals of NLP techniques [Level 2 - Understand]<br>**CO2**: Apply Language modelling techniques for predictions [Level 3 – Apply]<br>**CO3:** Apply Deep learning Techniques to build NLP Model. [Level 3 – Apply]<br>**CO4:** Outline the application of NLP Techniques. [Level 3 – Apply] | | |
| Course Content: | | | |
| Module 1 | Pre-processing Techniques | Assessment: Assignment | 8 Sessions |
| Topics:<br>Introduction to Natural Language Processing- terminologies, empirical rules, why NLP is hard, why NLP is useful<br>Natural Language generation<br>NLP Processing pipeline | | | |

Corpus Cleaning techniques – word tokenization, sentence tokenization, word frequency distribution, stemming, lemmatization, dictionary, Part of Speech Tagging, optical character recognition

Textual Pre-Processing techniques – Stop words removal, regular expression, lower case, text standardization.

Punctuation Mark Removal.

| | | | |
|---|---|---|---|
| Module 2 | Language Model | Assessment : Quiz + Assignment | 7 Sessions |

Topics:
Word Embeddings techniques- bag of words, Tf-iDF, Word2Vec and optimization.
Hidden Markov Models Simple N-gram models.
Estimating parameters and smoothing.
Negative Sampling Evaluating language models. (Forward and Viterbi algorithms and EM training)
Maximum Entropy Models
N-gram and unigram.

| | | | |
|---|---|---|---|
| Module 3 | Deep Learning techniques for NLP models | Assessment : Assignment | 8 Sessions |

Topics:
Introduction to Neural Network

Perceptron

Back Propagation

Recurrent Neural network

LSTM

Attention Models

BERT (Bidirectional Encoder Representation from Transformer)

Reformer

Speech recognition

Document summarization

| | | | |
|---|---|---|---|
| Module 4 | Application of NLP | Assessment : Assignment | 7 Sessions |

Topics:
Application of NLP- Lexical semantics and word-sense disambiguation
Named entity recognition and relation extraction
IE using sequence labelling
Emotion Extraction
tExt Summarization.

**List of Laboratory Tasks:**

**Experiment 1: Text Preprocessing and Word Frequency Analysis**

Level 1: Apply tokenization, stop-word removal, stemming, and lemmatization to a given corpus and visualize word frequency distribution.

Level 2: Develop a complete preprocessing pipeline and compare word frequencies before and after preprocessing.

**Experiment 2: Text Normalization and Vocabulary Analysis**

Level 1: Perform text normalization using lowercasing, punctuation removal, and regular expressions.

Level 2: Analyze vocabulary size, unique words, and lexical diversity of the corpus.

**Experiment 3: Word Embedding using Bag of Words**
Level 1: Create Bag of Words representations for a collection of documents.
Level 2: Implement a custom Bag of Words model and compare its output with Scikit-learn.
**Experiment 4: Word Embedding using TF-IDF**
Level 1: Generate TF-IDF vectors for a text dataset.
Level 2: Compare Bag of Words and TF-IDF representations for text classification tasks.
**Experiment 5: Word2Vec Continuous Bag of Words (CBOW)**
Level 1: Train a CBOW model on a text corpus and generate word embeddings.
Level 2: Analyze semantic similarity between words using the generated embeddings.
**Experiment 6: Word2Vec Skip-Gram Model**
Level 1: Implement the Skip-Gram model and generate vector representations.
Level 2: Compare CBOW and Skip-Gram models in terms of performance and word similarity.
**Experiment 7: Build Language Model using N-Gram**
Level 1: Construct unigram, bigram, and trigram language models.
Level 2: Evaluate language model performance using probability estimation and smoothing techniques.
**Experiment 8: Build NLP Model using LSTM**
Level 1: Implement an LSTM-based model for text classification.
Level 2: Tune model parameters and evaluate classification performance.
**Experiment 9: Build NLP Model using GRU**
Level 1: Develop a GRU-based text classification model.
Level 2: Compare GRU and LSTM models using accuracy and training time metrics.
**Experiment 10: Build NLP Model using BERT**
Level 1: Use a pre-trained BERT model for text classification.
Level 2: Fine-tune BERT and analyze improvements in performance.
**Experiment 11: Fine-Tune RoBERTa for Text Classification**
Level 1: Implement RoBERTa for sentiment or document classification.
Level 2: Compare RoBERTa and BERT performance on the same dataset.
**Experiment 12: Build NLP Model using Reformer**
Level 1: Implement a Reformer-based NLP model for efficient text processing.
Level 2: Evaluate memory and computational efficiency against transformer-based models.
**Experiment 13: Model Optimization and Efficient Architectures**
Level 1: Apply hyperparameter tuning and optimization techniques to NLP models.
Level 2: Compare optimized and non-optimized models using evaluation metrics.
**Experiment 14: Word Sense Disambiguation using Contextual Embeddings**
Level 1: Use contextual embeddings to identify the correct meaning of ambiguous words.
Level 2: Compare traditional and contextual approaches for word-sense disambiguation.
**Experiment 15: Named Entity Recognition and Relation Extraction using Sequence Labeling**
Level 1: Implement Named Entity Recognition using sequence labeling techniques.
Level 2: Extract relationships between identified entities and evaluate extraction performance.

| Targeted Applications & Tools: | |
|---|---|
| Python | Natural Language Processing, Machine Learning, Text Analytics, Deep Learning Model Developmen |
| Jupyter Notebook | Interactive Coding, Model Development, Data Visualization, Experimentation |
| Google Colab | Cloud-Based NLP Development, Deep Learning Training, Collaborative Experiments |
| NLTK | Text Preprocessing, Tokenization, Stemming, Lemmatization, POS Tagging |
| PyTorch | Advanced Deep Learning, Transformer Models, Research Prototyping |
| Pandas | Data Manipulation, Corpus Handling, Data Analysis |

| Skill-Building Activities through Experiential Learning: |
|---|
| • Perform text preprocessing tasks such as tokenization, stemming, lemmatization, and stop-word removal on real-world text datasets.<br>• Implement and compare text representation techniques including Bag of Words, TF-IDF, Word2Vec, and N-gram models for language analysis.<br>• Develop NLP applications such as sentiment analysis and named entity recognition using Python libraries and evaluate their performance.<br>• Apply deep learning models such as RNN, LSTM, and BERT for tasks including text classification, document summarization, and speech recognition. |
| Text Book<br>**T1:** Daniel Jurafsky, James H. MartinSpeech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, Pearson Publication, 3rd Edition, 2020.<br><br>**T2:** Steven Bird, Ewan Klein and Edward Loper, Natural Language Processing with Python, First Edition, OReilly Media, 2009. |
| References<br>R1: Breck Baldwin, Language Processing with Java and LingPipe Cookbook, Atlantic Publisher, 2015.<br><br>R2: Richard M Reese, Natural Language Processing with Javall, OReilly Media, 2015. .<br>R3: Nitin Indurkhya and Fred J. Damerau, Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010.<br>R4: Tanveer Siddiqui, U.S. Tiwary, Natural Language Processing and Information Retrieval, Oxford University Press, 2008. |
| E-Resources/Web Resources<br>8. https://presiuniv.knimbus.com/user#/home<br>9. https://www.ibm.com/in-en/topics/natural-language-processing<br>10. https://nptel.ac.in/courses/108105572 |

| Course Code: AIE4012 | Course Name: Machine Vision<br>Type of Course: Theory Course | L- T-P- C | 3-0-0-3 |
|---|---|---|---|
| Version No. | 1.0 | | |
| NCrF Level- | 6.0 | | |
| Course Pre-requisites | NIL | | |
| Co-requisites | NiL | | |
| Anti-requisites | NiL | | |
| Course Description | This course explores the principles and techniques of machine vision, focusing on image processing, object recognition, motion analysis, and 3D vision. It integrates foundational methods with modern AI-driven approaches such as deep learning, vision transformers, and SLAM to enable intelligent visual perception in industrial and real-world applications. | | |
| Course Objective | • Understand the principles of image processing and machine vision techniques.<br>• Apply image enhancement, feature extraction, segmentation, and recognition methods to visual data.<br>• Analyze motion tracking, camera calibration, and 3D vision techniques for intelligent perception. | | |

<table>
<tr><td></td><td colspan="3"><ul><li>Evaluate classical and deep learning approaches for machine vision applications.</li><li>Design and implement real-world vision-based solutions using modern computer vision and AI tools</li></ul></td></tr>
<tr><td>Course Outcomes</td><td colspan="3">On successful completion of the course the students shall be able to:<br><br>CO1:Apply mathematical and spatial techniques to enhance and transform images using spatial and frequency domain methods. [Level 3 -Apply]<br>CO2: Analyze image segmentation, feature detection, and motion tracking techniques to solve real-world vision problems. [Level 4 – Analyze]<br>CO3:.Compare camera calibration models and projective geometry transformations for accurate 3D vision analysis [Level 4 – Analyze]<br>CO4:Justify the selection of machine vision techniques for applications such as surveillance and object recognition. [Level 5 – Evaluate]<br>CO5:Design and implement vision-based solutions using classical and deep learning approaches. [Level 6 – Create]</td></tr>
<tr><td colspan="4">Course Content:</td></tr>
<tr><td>Module 1</td><td>Fundamentals of Image Processing</td><td>Assessment: Assignment</td><td>9 Sessions</td></tr>
<tr><td colspan="4">Topics:<ul><li>Introduction to digital image processing</li><li>Image formation and pixel representation</li><li>Grey-level transformations and histogram equalization</li><li>Spatial filtering: smoothing and sharpening techniques</li><li>Morphological operations: dilation, erosion, opening, closing</li></ul></td></tr>
<tr><td>Module 2</td><td>Frequency Domain & Deep Learning Basics</td><td>Assessment : Quiz + Assignment</td><td>8 Sessions</td></tr>
<tr><td colspan="4">Topics:<ul><li>Discrete Fourier Transform (DFT)</li><li>Fast Fourier Transform (FFT)</li><li>Frequency domain filtering</li><li>Introduction to deep learning for image denoising</li><li>Vision Transformers (ViT): basics and applications in low-level vision</li></ul></td></tr>
<tr><td>Module 3</td><td>Feature Detection, Segmentation & Recognition</td><td>Assessment : Assignment</td><td>10 Sessions</td></tr>
<tr><td colspan="4">Topics:<ul><li>Edge and corner detection (Sobel, Canny, Harris)</li><li>Feature descriptors: SIFT, SURF, ORB</li><li>Image segmentation:<ul><li>Thresholding</li></ul></li></ul></td></tr>
</table>

- Region growing
- Texture-based segmentation

- Object recognition using classifiers
- Viola–Jones algorithm for face detection
- YOLO and SSD (introductory)

| Module 4 | Motion Analysis and Tracking | Assessment : Assignment | 09 Sessions |
|---|---|---|---|

Topics:

- Optical flow: Lucas-Kanade, Horn-Schunck
- Feature tracking using template matching
- Motion-based segmentation
- Kalman Filter and Particle Filter basics
- Tracking algorithms: Mean-shift, CAM-shift
- Real-time tracking using Deep SORT

| Module 5 | Camera Models, 3D Vision & Advanced Applications | Assessment : Assignment | 09 Sessions |
|---|---|---|---|

Topics:

- Camera projection models: orthographic, affine, perspective
- Intrinsic and extrinsic camera parameters
- Camera calibration techniques (linear, non-linear, multi-plane)
- Epipolar geometry and stereo correspondence
- 3D reconstruction from stereo vision
- Visual serving basics
- Introduction to SLAM
- Monocular depth estimation using deep learning

Targeted Applications & Tools:

| | |
|---|---|
| MATLAB | Prototyping image enhancement, segmentation, and frequency domain analysis using built-in vision and image processing toolboxes |
| OpenCV (with Python) | Developing real-time machine vision systems for tasks like object detection, gesture recognition, and tracking |
| Python (NumPy, scikit-image, TensorFlow, PyTorch) | Building AI-driven vision applications including classification, face recognition, and image feature extraction |
| LabelImg / CVAT | Annotating datasets for supervised learning-based image classification and segmentation |
| ROS (Robot Operating System) | Integrating camera sensors and deploying real-time vision algorithms in robotics applications like SLAM and visual servoing |

Skill-Building Activities through Experiential Learning:

- **Real-Time Face Detection Using OpenCV**
  Develop a real-time face detection system using OpenCV and Haar cascade classifiers. This

activity reinforces concepts of feature extraction, region of interest (ROI), and image preprocessing techniques in live video streams.

- **3D Pose Estimation and Camera Calibration**
  Perform geometric calibration of a stereo camera setup using checkerboard patterns. Apply epipolar geometry and projection models to estimate object poses in 3D space, integrating computer vision with robotics-oriented applications.

- **Traffic Sign Recognition with Deep Learning**
  Build and train a convolutional neural network (CNN) to classify traffic signs using an open dataset. Apply segmentation techniques and real-time classification to simulate autonomous vehicle perception modules.

Text Book

**T1:** R. C. Gonzalez, R. E. Woods, 'Digital Image Processing', Pearson,2017.

**T2:** Introduction to Computer Vision and its Application, Richard Szelinski,2021.

References

**R1:** Emanuele Trucco and Alessandro Verri, "Introductory Techniques for 3-D Computer Vision", Prentice Hall, 1998.
**R2:** Olivier Faugeras, "Three Dimensional Computer Vision", MIT Press, 1993.
**R3:** Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011.
**R4:** Milan Sonka, Vaclav Hlavac and Roger Boyle, "Image Processing, Analysis and Machine Vision", Third Edition, CL Engineering, 2013.
**R5:** Marco Treiber, "An Introduction to Object Recognition Selected Algorithms for a Wide Variety of Applications", Springer, 2010.
**R6:** Forsyth and Ponce, "Computer Vision – A Modern Approach", Second Edition, Prentice Hall, 2011.

E-Resources/Web Resources

1. https://www.geeksforgeeks.org/electrical-engineering/what-is-machine-vision/
2. https://www.classcentral.com/subject/machine-vision

| Course Code: AIE4021 | Course Name: AI Ethics and Responsible AI<br>Type of Course: Integrated Course | L- T-P- C | 2-0-2-3 |
|---|---|---|---|
| Version No. | 2.0 | | |
| NCrF Level- | -- | | |
| Course Pre-requisites | NIL | | |
| Co-requisites | NiL | | |
| Anti-requisites | Nil | | |
| Course Description | This course introduces the ethical, social, and regulatory aspects of Artificial Intelligence .It covers principles such as fairness, accountability, transparency, privacy, and responsible AI development. Students will learn about AI bias, explainable AI, governance frameworks, global regulations, and ethical challenges in real-world AI applications. The course also provides hands-on experience in evaluating and developing trustworthy and responsible AI solutions. | | |
| Course Objective | The course aims to:<br>1.Understand the principles of AI ethics and responsible use.<br>2.Analyze ethical issues in AI applications including fairness, accountability, and transparency.<br>3.Apply responsible AI frameworks, regulations, and governance models. | | |

| | | | |
|---|---|---|---|
| | 4.Develop fair, explainable, and transparent AI models through hands-on practice. | | |
| Course Outcomes | **On successful completion of the course the students shall be able to:**<br><br>**CO1:** Explain the foundations of AI ethics and responsible AI practices. [Level 2 - Understand]<br>**CO2**: Analyze bias, fairness, accountability, and transparency challenges in AI systems. [Level 4 – Analyze]<br>**CO3**: Apply governance frameworks, regulations, and ethical design principles in AI deployment. [Level 3 – Apply]<br>**CO4:** Design and evaluate responsible AI models with fairness and explainability features [Level 6 – Create] | | |
| Course Content: | | | |
| Module 1 | Foundation of AI ethics | Assessment: Assignment + Case Studies | 6 Sessions |
| Topics:<br><br>History and evolution of AI ethics, principles of fairness accountability transparency privacy, global guidelines IEEE OECD UNESCO, responsible AI for sustainable development, ethical case studies. | | | |
| Module 2 | Fairness, Bias, and Accountability | Assignment: Bias Identification in AI Applications | 6 Sessions |
| Topics:<br>Algorithmic bias and discrimination, data imbalance issues, ethical concerns in facial recognition recruitment credit scoring, accountability frameworks, governance models, fairness toolkits IBM AI Fairness 360. | | | |
| Module 3 | Transparency, Explainability, and Governance | Assignment: Explainable AI Demonstration | 8 Sessions |
| **Topics:**<br><br>Transparency and interpretability in AI systems, explainable AI techniques LIME SHAP, trust in AI models, legal and regulatory aspects GDPR right to explanation, trustworthy AI systems. | | | |
| Module 4 | Responsible AI in Practice | Assignment: Responsible AI Application Analysis | 10 Sessions |
| **Topics:**<br>Responsible AI in healthcare finance cybersecurity smart cities, AI governance, corporate responsibility, global policy initiatives, ethical challenges in generative AI autonomous systems, responsible AI solutions mini-project. | | | |
| **List of Laboratory Tasks:**<br><br>1 – Ethics in Real-world AI<br>Case study analysis of unethical AI use cases.<br>2 – Dataset Bias Detection<br>Exploring bias in datasets (UCI Adult dataset).<br>3 – Fairness Metrics<br>Using IBM AI Fairness 360 Toolkit.<br>4 – Bias Mitigation<br>Implement reweighing/adversarial debiasing.<br>5 – Explainable AI<br>Apply LIME/SHAP for model interpretability.<br>6 – AI Ethics Governance Roleplay | | | |

Simulate an Ethics Board & prepare impact assessment.

7 – Policy and Framework Analysis

Compare EU AI Act, IEEE, NITI Aayog guidelines.

8 – Deepfakes & Generative AI

Analyze risks and detection techniques.

9 – Mini Project: Responsible AI Design

Build a small ML model with fairness + XAI.

10 – Project Presentation & Reflection

Students present responsible AI solutions & audit

Targeted Applications & Tools:

- Python – Programming and AI model development.
- Jupyter Notebook – Interactive environment for AI experimentation.
- Scikit-learn – Machine learning model development.
- IBM AI Fairness 360 (AIF360) – Fairness assessment and bias mitigation.
- LIME (Local Interpretable Model-Agnostic Explanations) – Explainable AI.
- SHAP (SHapley Additive exPlanations) – Model interpretability and explanation.
- TensorFlow – AI and deep learning framework. TensorFlow
- PyTorch – Deep learning and AI model development. PyTorch

Skill-Building Activities through Experiential Learning:

- Analyze real-world AI ethics case studies involving bias, privacy breaches, and algorithmic discrimination.
- Explore and identify bias in publicly available datasets such as the UCI Adult Dataset.
- Implement bias mitigation techniques such as reweighing and adversarial debiasing.

Text Book

**T1:** Virginia Dignum, Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way, Springer Nature, 2019.
**T2:** Mark Coeckelbergh, AI Ethics, The MIT Press, 2020.

References

**R1:** Stuart Russell, Human Compatible: Artificial Intelligence and the Problem of Control, Viking, 2019.

**R2:** Melanie Mitchell, Artificial Intelligence: A Guide for Thinking Humans, Farrar, Straus and Giroux, 2019.

E-Resources/Web Resources

**W1:** OECD AI Principles
**W2:** UNESCO Recommendation on the Ethics of Artificial Intelligence

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|---|---|---|---|
| Course Code: DSC4012 | Course Name: Data Security and Access Control<br>Type of Course: Theory Course | L- T-P- C | 3-0-0-3 |
| Version No. | 2.0 | | |
| NCrF Level- | 5.0 | | |
| Course Pre-requisites | NIL | | |
| Co-requisites | NiL | | |
| Anti-requisites | CSEXXXX | | |

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|---|---|
| Course Description | This course describes fundamental issues and problems in data security and provides technical solutions or facets to the problem of achieving data security. The course also deals with the security of statistical databases, discusses authorization systems, and covers the fundamental ideas of cryptography. |
| Course Objective | The objective of the course is to familiarize the learners with the concepts of Data Security and Access Control and attain employability skills through Participative Learning techniques. |
| Course Outcomes | **On successful completion of the course the students shall be able to:**<br><br>**CO1:** Describe the fundamental concepts and principles of data security including confidentiality, integrity, availability, and security models. [Level 2 - Understand]<br>**CO2**: Analyze security problems in computing systems and classical encryption standards. [Level 4 – Analyze]<br>**CO3:** Apply data security techniques such as data masking, data erasure, backup storage, and anti-malware protection to safeguard data [Level 3 – Apply]<br>**CO4:** Examine authorization mechanisms and access control models to address security challenges in networked systems [Level 4 – Analyze]<br>**CO5:** Design and simulate secure access control mechanisms using appropriate data security algorithms and tools [Level 3 – Apply]<br>**CO6:** Evaluate data security policies, regulatory frameworks (GDPR, Indian Data Protection Act), and organizational security practices. [Level 5 – Evaluate] |

Course Content:

| | | | |
|---|---|---|---|
| Module 1 | Fundamentals of Data Security | Assessment: Assignment | 10 Sessions |

Topics:
Introduction to Data Security, Confidentiality, Integrity, Availability
Visibility
Automation
Monitoring
Models and Methodology
The Security Problem in Computing
The Data Encryption Standard

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|---|---|---|---|
| Module 2 | Data Security Techniques | Assessment : Demonstration | 12 Sessions |

Topics:
Introduction, data masking, data erasure, and backup storage
Anti-malware protection
Viruses and other malicious code
Security in Key specified model
Security in Characteristic specified model
File Protection Mechanisms.

| | | | |
|---|---|---|---|
| Module 3 | Authorization Mechanisms in Data Security: | Assessment : Assignment | 12 Sessions |

Topics:
Introduction, concept of Un-decidability
Authorization Systems with Tractable Safety Problem
Grammatical Authorization Systems
Threats in Network
Network Security Controls.

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|---|---|---|---|
| Module 4 | An Overview of Data Security Tools, Data Security Policies : | Assessment : Quiz and Demonstration | 11 Sessions |

Topics:
Introduction to tools available for Data Security
Demonstration of Security features in Linux platform
Simulation using more than two computers
Ddemonstration of data leakage during transmission
GDPR (General Data Protection Regulation)
Comparative study with India regulation, Data Privacy Act
Role Based Access Control
Organizational Security policies.

Targeted Applications & Tools:

| | |
|---|---|
| Linux (Ubuntu/Kali Linux) | User Authentication and Authorization Systems |
| Wireshark | Network Security Monitoring and Traffic Analysis |
| VirtualBox / VMware | Security Testing and Virtualized Security Labs |

Skill-Building Activities through Experiential Learning:

- Simulate unauthorized access attempts and evaluate access control effectiveness.
- Analyze network packets using Wireshark to identify security vulnerabilities.
- Configure user accounts, groups, and permissions in Linux..

Text Book

**T1:** Data Privacy and Security, David Solomon, Springer, 2020.
**T2:** Principles of Data Security, Ernst L. Leiss, Plenum Press, New York and London, 2021.

References

**R1:** Intelligence and Security Informatics for International Security, Chen, Hsinchun, Springer Publication, 2006.
**R2:** Certified Information Security Professional (CSIP) web portal.

E-Resources/Web Resources

11. https://presuniv.knimbus.com/user#/home
12. https://www.datasunrise.com/professional-info/what-is-access-control/

| | | | |
|---|---|---|---|
| Course Code: DSC4013 | Course Name: Soft computing Techniques<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 | NiL | | |
| Anti-requisites | CSEXXXX | | |
| Course Description | This course introduces the principles of soft computing techniques and their applications in Data Science. Unlike hard computing, soft computing approaches are tolerant of imprecision, uncertainty, and approximation, making them highly effective for real-world data-driven problems. The course covers fuzzy logic, artificial neural networks, evolutionary computation, swarm intelligence, and hybrid models, with an emphasis on how these methods can be applied to solve optimization, classification, clustering, and prediction problems in Data Science. | | |
| Course Objective | •To understand the foundational concepts of soft computing and its role in | | |

| | |
|---|---|
| | Data Science.<br>•To analyze fuzzy systems, neural networks, and evolutionary algorithms for intelligent problem-solving.<br>•To apply soft computing techniques for modeling, optimization, and prediction.<br>•To design hybrid soft computing systems and interpret their applications in real-world Data Science domains. |
| Course Outcomes | **On successful completion of the course the students shall be able to:**<br><br>**CO1:** Understand the basics of fuzzy logic, neural networks, and evolutionary algorithms. [Level 2 - Understand]<br>**CO2**: Analyze fuzzy sets, inference systems, and clustering methods for decision-making. [Level 4 – Analyze]<br>**CO3:** Analyze neural networks and evolutionary algorithms for data-driven problem solving. [Level 4 – Analyze]<br>**CO4:** Apply hybrid soft computing and swarm intelligence to Data Science applications. [Level 3 – Apply] |

Course Content:

| | | | |
|---|---|---|---|
| Module 1 | Introduction to Soft Computing | Assignment : Soft Computing Applications Survey | 10 Sessions |
| Topics:<br>Soft computing vs. hard computing; need and applications in Data Science; components of soft computing – fuzzy logic, neural networks, evolutionary algorithms, and probabilistic reasoning; real-world case studies in approximation and uncertainty handling. | | | |
| Module 2 | Fuzzy Logic and Systems | Assignment : Design of a Fuzzy Rule-Based System | 11 Sessions |
| Topics:<br>Fuzzy sets and membership functions; fuzzy operations and relations; fuzzy rule-based systems; fuzzy inference mechanisms (Mamdani and Sugeno models); fuzzy clustering (Fuzzy C-Means); applications in decision-making, pattern recognition, and classification. | | | |
| Module 3 | Artificial Neural Networks and Evolutionary Computation | Assignment : Neural Network Implementation | 12 Sessions |
| Topics:<br>Biological vs. artificial neurons; feedforward networks, multilayer perceptrons; backpropagation learning algorithm; Hopfield networks; introduction to deep learning as soft computing; evolutionary algorithms – genetic algorithms, genetic programming, and applications in optimization and feature selection. | | | |
| Module 4 | Hybrid Soft Computing and Swarm Intelligence | Assignment : Swarm Intelligence Study | 12 Sessions |
| Topics:<br>Hybrid systems – neuro-fuzzy, genetic-fuzzy, and neuro-genetic models; swarm intelligence – particle swarm optimization (PSO), ant colony optimization (ACO); rough sets; applications in big data analytics, clustering, anomaly detection, and predictive modeling in cloud and IoT environments; emerging trends in soft computing for Data Science. | | | |

Targeted Applications & Tools:

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|---|---|
| RapidMiner | Predictive Analytics and Knowledge Discovery |
| DEAP | Genetic Algorithm-Based Optimization and Feature Selection |
| PyGAD | Evolutionary Computing and Optimization Problems |
| PySwarms | Particle Swarm Optimization for Resource Allocation and Routing |

Skill-Building Activities through Experiential Learning:

- Compare hard computing and soft computing techniques for solving real-world problems involving uncertainty and imprecision.
- Design fuzzy membership functions and rule-based systems for decision-making applications

such as temperature control, risk assessment, and performance evaluation.

- Implement fuzzy inference systems using software tools and analyze their effectiveness in handling uncertain data.
- Perform clustering and classification of datasets using Fuzzy C-Means and compare the results with conventional techniques.

Text Book

**T1:** S. N. Sivanandam and S. N. Deepa, *Principles of Soft Computing*, Wiley India, 2nd Edition, 2011.

**T2:** Kwang H. Lee, *First Course on Fuzzy Theory and Applications*, Springer, 2005.

References

**R1:** J. S. R. Jang, C. T. Sun, and E. Mizutani, Neuro-Fuzzy and Soft Computing, Prentice Hall, 1997.
**R2:** S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications, PHI Learning, 2017.
**R3:** David E. Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning, Addison Wesley, 1989.

E-Resources/Web Resources

[W1] https://towardsdatascience.com/ (search: fuzzy logic, GA, ANN, PSO)
[W2] Difference between Soft Computing and Hard Computing - GeeksforGeeks
[W3] Need for Soft Computing - GeeksforGeeks
[W4] Probabilistic Reasoning in Artificial Intelligence - GeeksforGeeks