PRESIDENCY UNIVERSITY

Private University Estd. in Karnataka State by Act No. 41 of 2013

Itgalpura, Rajankunte, Yelahanka, Bengaluru – 560064

PRESIDENCY SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

Program Regulations and Curriculum

2025-2029

BACHELOR OF TECHNOLOGY (B.Tech.) in

Robotics and Artificial Intelligence (RAI)

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

Regulation Number: PU/AC-26.9/SoCSE6/RAI/2025-2029

Resolution No. 9 of the 26th Meeting of the Academic Council held on 25th July 2025, and ratified by the Board of Management in its 27th Meeting held on 28th July 2025.

July 2025

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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 School of Computer Science and Engineering, committed to developing globally-competent Engineers, dedicated to transforming Society.

1.4 Mission of Presidency School of Computer Science and Engineering

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

2. Preamble to the Program Regulations and Curriculum

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

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

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

3. Short Title and Applicability

a. These Regulations shall be called the Bachelor of Technology Degree Program Regulations and Curriculum 2025-2029.
b. These Regulations are subject to, and pursuant to the Academic Regulations.
c. These Regulations shall be applicable to the ongoing Bachelor of Technology Degree Programs of the 2025-2029 batch, and to all other Bachelor of Technology Degree Programs which may be introduced in future.
d. These Regulations shall supersede all the earlier Bachelor of Technology Degree Program Regulations and Curriculum, along with all the amendments thereto.
e. These Regulations shall come into force from the Academic Year 2025-2026.

4. Definitions

In these Regulations, unless the context otherwise requires:

a. "Academic Calendar" means the schedule of academic and miscellaneous events as approved by the Vice Chancellor;

b. "Academic Council" means the Academic Council of the University;

c. "Academic Regulations" means the Academic Regulations, of the University;

d. "Academic Term" means a Semester or Summer Term;

e. "Act" means the Presidency University Act, 2013;

f. "AICTE" means All India Council for Technical Education;

g. "Basket" means a group of courses bundled together based on the nature/type of the course;

h. "BOE" means the Board of Examinations of the University;

i. "BOG" means the Board of Governors of the University;

j. "BOM" means the Board of Management of the University;

k. "BOS" means the Board of Studies of a particular Department/Program of Study of the University;

l. "CGPA" means Cumulative Grade Point Average as defined in the Academic Regulations;

m. "Clause" means the duly numbered Clause, with Sub-Clauses included, if any, of these Regulations;

n. "COE" means the Controller of Examinations of the University;

o. "Course In Charge" means the teacher/faculty member responsible for developing and organising the delivery of the Course;

p. "Course Instructor" means the teacher/faculty member responsible for teaching and evaluation of a Course;

q. "Course" means a specific subject usually identified by its Course-code and Course-title, with specified credits and syllabus/course-description, a set of references, taught by some teacher(s)/course-instructor(s) to a specific class (group of students) during a specific Academic Term;

r. "Curriculum Structure" means the Curriculum governing a specific Degree Program offered by the University, and, includes the set of Baskets of Courses along with minimum credit requirements to be earned under each basket for a degree/degree with specialization/minor/honours in addition to the relevant details of the Courses and Course catalogues (which describes the Course content and other important information about the Course). Any specific requirements for a particular program may be brought into the Curriculum structure of the specific program and relevant approvals should be taken from the BOS and Academic Council at that time.

s. "DAC" means the Departmental Academic Committee of a concerned Department/Program *of Study of the University;*

t. "Dean" means the Dean / Director of the concerned School;

u. "Degree Program" includes all Degree Programs;

v. "Department" means the Department offering the degree Program(s) / Course(s) / School offering the concerned Degree Programs / other Administrative Offices;

w. "Discipline" means specialization or branch of B.Tech. Degree Program;

x. "HOD" means the Head of the concerned Department;

y. "L-T-P-C" means Lecture-Tutorial-Practical-Credit – refers to the teaching – learning periods and the credit associated;

z. "MOOC" means Massive Open Online Courses;

aa. "MOU" means the Memorandum of Understanding;

bb. "NPTEL" means National Program on Technology Enhanced Learning;

cc. "Parent Department" means the department that offers the Degree Program that a student undergoes;

dd. "Program Head" means the administrative head of a particular Degree Program/s;

ee. "Program Regulations" means the Bachelor of Technology Degree Program Regulations and Curriculum, 2025-2029;

ff. "Program" means the Bachelor of Technology (B.Tech.) Degree Program;

gg. "PSCS" means the Presidency School of Computer Science and Engineering;

hh. "Registrar" means the Registrar of the University;

ii. "School" means a constituent institution of the University established for monitoring, supervising and guiding, teaching, training and research activities in broadly related fields of studies;

jj. "Section" means the duly numbered Section, with Clauses included in that Section, of these Regulations;

kk. "SGPA" means the Semester Grade Point Average as defined in the Academic Regulations;

ll. "Statutes" means the Statutes of Presidency University;

mm. "Sub-Clause" means the duly numbered Sub-Clause of these Program Regulations;

nn. "Summer Term" means an additional Academic Term conducted during the summer break (typically in June-July) for a duration of about eight (08) calendar weeks, with a minimum of thirty (30) University teaching days;

oo. "SWAYAM" means Study Webs of Active Learning for Young Aspiring Minds.

pp. "UGC" means University Grant Commission;

qq. "University" means Presidency University, Bengaluru; and

rr. "Vice Chancellor" means the Vice Chancellor of the University.

5. Program Description

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

1. Bachelor of Technology in Computer Science and Engineering, abbreviated as CSE
2. Bachelor of Technology in Computer Science and Technology (Big Data), abbreviated as CBD
3. Bachelor of Technology in Computer Science and Engineering (Block Chain), abbreviated as CBC
4. Bachelor of Technology in Computer Science and Technology (Dev Ops), abbreviated as CDV
5. Bachelor of Technology in Computer Science and Engineering (Cyber Security), abbreviated as CCS
6. Bachelor of Technology in Computer Science and Engineering (Internet of Things), abbreviated as CIT
7. Bachelor of Technology in Computer Science and Engineering (Data Science), abbreviated as CSD
8. Bachelor of Technology in Information Science and Technology, abbreviated as IST
9. Bachelor of Technology in Information Science and Engineering, abbreviated as ISE
10. Bachelor of Technology in Computer Science and Engineering (Artificial Intelligence and Machine Learning) abbreviated as CAI
11. Bachelor of Technology in Robotics and Artificial Intelligence abbreviated as RAI
12. Bachelor of Technology in Artificial Intelligence and Data Science abbreviated as ADS

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 Bachelor of Technology Degree Program is a Four-Year, Full-Time Semester based program. The minimum duration of the B.Tech. Program is four (04) years and each year comprises of two academic Semesters (Odd and Even Semesters) and hence the duration of the B.Tech. program is eight (08) Semesters.

6.2 A student who for whatever reason is not able to complete the Program within the normal period or the minimum duration (number of years) prescribed for the Program, may be allowed a period of two years beyond the normal period to complete the mandatory minimum credits requirement as prescribed by the concerned Program Regulations and Curriculum. In general, the permissible maximum duration (number of years) for completion of Program is 'N' + 2 years, where 'N' stands for the normal or minimum duration (number of years) for completion of the concerned Program as prescribed by the concerned Program Regulations and Curriculum.

6.3 The time taken by the student to improve Grades/CGPA, and in case of temporary withdrawal/re-joining (Refer to Clause **Error! Reference source not found.** 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.**Error! Reference source not found.** of Academic Regulations) in the prescribed maximum duration (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: Demonstrate as a Computer Engineering Professional with innovative skills And moral and ethical values.
PEO 02: Engage in lifelong learning through research and professional development
PEO 03: Serve as a leader in the profession through consultancy, extension activities and/or entrepreneurship

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

8.2 Program Specific Outcomes (PSOs):

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

PSO1:Develop innovative, cost-effective robotic systems that address the needs of industry and society.

PSO2:Utilize programming expertise and ethically grounded AI practices to create and implement intelligent robotic solutions with a focus on societal impact.

PSO3:Apply the knowledge and skills acquired in Robotics and Artificial Intelligence to solve complex, real-world engineering problems across multidisciplinary domains.

9 Admission Criteria (as per the concerned Statutory Body)

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

9.1 An applicant who has successfully completed Pre-University course or Senior Secondary School course (+2) or equivalent such as (11+1), 'A' level in Senior School Leaving Certificate Course from a recognized university of India or outside or from Senior Secondary Board or equivalent, constituted or recognized by the Union or by the State Government of that Country for the purpose of issue of qualifying certificate on successful completion of the course, may apply for and be admitted into the Program.

9.2 Provided further, the applicant must have taken Physics and Mathematics as compulsory subjects in the Pre-University / Higher Secondary / (10+2) / (11+1) examination, along with either Chemistry / Biology / Electronics / Computer Science / Biotechnology subject, and, the applicant must have obtained a minimum of 45% of the total marks (40% in case of candidates belonging to the Reserved Category as classified by the Government of Karnataka) in these subjects taken together.

9.3 The applicant must have appeared for Joint Entrance Examinations (JEE) Main / JEE (Advanced) / Karnataka CET / COMED-K, or any other State-level Engineering Entrance Examinations.

9.4 Reservation for the SC / ST and other backward classes shall be made in accordance with the directives issued by the Government of Karnataka from time to time.

9.5 Admissions are offered to Foreign Nationals and Indians living abroad in accordance with the rules applicable for such admission, issued from time to time, by the Government of India.

9.6 Candidates must fulfil the medical standards required for admission as prescribed by the University.

9.7 If, at any time after admission, it is found that a candidate had not in fact fulfilled all the requirements stipulated in the offer of admission, in any form whatsoever, including possible misinformation and any other falsification, the Registrar shall report the matter to the Board of Management (BOM), recommending revoking the admission of the candidate.

9.8 The decision of the BOM regarding the admissions is final and binding.

Lateral Entry / Transfer Students requirements

10.1 Lateral Entry

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

10.1.1 Admission to 2nd year (3rd Semester) of the B.Tech. Degree program shall be open to the candidates who are holders of a 3-year Diploma in Engineering (or equivalent qualification as recognized by the University), who have secured not less than forty-five percentage (45%) marks in the final year examination (5th and 6th Semesters of the Diploma Program) in the appropriate branch of Engineering. Provided that, in case of SC / ST and OBC candidates from Karnataka the minimum marks for eligibility shall be forty percent (40%).

10.1.2 Provided further that, candidates seeking Lateral Entry may be required to complete specified bridge Courses as prescribed by the University. Such bridge Courses, if any, shall not be included in the CGPA computations.

10.1.3 All the existing Regulations and Policies of the University shall be binding on all the students admitted to the Program through the provision of Lateral Entry.

10.1.4 The Course requirements prescribed for the 1st Year of the B.Tech. Program shall be waived for the student(s) admitted through Lateral Entry and the duration of the B.Tech. Program for such students is three (03) years, commencing from the 3rd Semester (commencement of the 2nd Year) of the B.Tech. Program and culminating with the 8th Semester (end of the 4th Year) of the B.Tech. Program.

10.1.5 Provided that, if a Lateral Entry student misses any mandatory program specific courses that are typically offered in the 1st year (1st or 2nd semesters), then those courses must be cleared by the students as soon as possible, preferably during the Summer Term.

10.1.6 The existing Program Regulations of the concerned Program to which the student is admitted through the provision of Lateral Entry shall be binding on the student with effect from the 3rd Semester of the Program. i.e., the Program Structure and Curriculum from the 3rd to 8th Semesters of the Program concerned shall be binding on the student admitted through Lateral Entry. Further, any revisions / amendments made to the Program Regulations thereafter, shall be binding on all the students of the concerned Program.

10.1.7 All the Courses (and the corresponding number of Credits) prescribed for the 1st Year of the concerned B.Tech. Program shall be waived for the student(s) admitted to the concerned B.Tech Program through Lateral Entry. Further, the *Minimum Credit Requirements* for the award of the B.Tech. Degree in the concerned Program shall be prescribed / calculated as follows:

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

For instance, if the *Minimum Credit Requirements* for the award of the Bachelor of Technology (B.Tech.) Degree as prescribed by the Regulations for B.Tech. (Robotics and Artificial Intelligence Engineering) is "N" Credits, and, if the total credits prescribed in the 1st Year (total credits of the 1st and 2nd Semesters) of the Program concerned is "M" Credits, then the *Minimum Credit Requirements* for the award of the B.Tech. in Robotics and Artificial Intelligence Engineering for a student who joins the Program through the provision of the Lateral Entry, shall be "N – M" Credits.

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

10.2 Transfer of student(s) from another recognized University to the 2nd year (3rd Semester) of the B.Tech. Program of the University

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

The concerned student fulfils the criteria specified in Sub-Clauses 10.1.1, 10.1.2 and 10.1.3.

10.2.1 The student shall submit the Application for Transfer along with a non-refundable Application Fee (as prescribed by the University from time to time) to the Presidency University no later than July 10 of the concerned year for admission to the 2nd Year (3rd Semester) B.Tech. Program commencing on August 1 on the year concerned.

10.2.2 The student shall submit copies of the respective Marks Cards / Grade Sheets / Certificates along with the Application for Transfer.

10.2.3 The transfer may be provided on the condition that the Courses and Credits completed by the concerned student in the 1st Year of the B.Tech. / B.E. / B.S. Four Degree Program from the concerned University, are declared equivalent and acceptable by the Equivalence Committee constituted by the Vice Chancellor for this purpose. Further, the Equivalence Committee may also prescribe the Courses and Credits the concerned students shall have to mandatorily complete, if admitted to the 2nd Year of the B.Tech. Program of the University.

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

11 Change of Branch / Discipline / Specialization

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

11.1 Normally, only those students, who have passed all the Courses prescribed for the 1st Year of the B.Tech. Program and obtained a CGPA of not less than 6.50 at the end of the 2nd Semester, shall be eligible for consideration for a change of Branch.

11.2 Change of Branch, if provided, shall be made effective from the commencement of the 3rd Semester of the B.Tech. Program. There shall be no provision for change of

Branch thereafter under any circumstances whatsoever.

11.3 The student provided with the change of Branch shall fully adhere to and comply with the Program Regulations of the concerned Branch of the B.Tech. Program, the Fee Policy pertaining to that Branch of the B.Tech. Program, and, all other rules pertaining to the changed Branch existing at the time.

11.4 Change of Branch once made shall be final and binding on the student. No student shall be permitted, under any circumstances, to refuse the change of Branch offered.

11.5 The eligible student may be allowed a change in Branch, strictly in order of *inter se* merit, subject to the conditions given below:

11.5.1 The actual number of students in the 3rd Semester in any particular Branch to which the transfer is to be made, should not exceed the intake fixed by the University for the concerned Branch;

11.5.2 The actual number of students in any Branch from which transfer is being sought does not fall below 75% of the total intake fixed by the University for the concerned Branch.

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

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

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

12.2 Academic performance evaluation of every registered student in every Course registered by the student is carried out through various components of Assessments spread across the Semester. The nature of components of Continuous Assessments and the weightage given to each component of Continuous Assessments (refer Clause 12.5 of Academic Regulations) shall be clearly defined in the Course Plan for every Course, and approved by the DAC.

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

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

- Non-Teaching Credit Courses (NTCC)

- Courses with a class strength less than 30

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

Grading shall be done at the end of the Academic Term by considering the aggregate performance of the student in all components of Assessments prescribed for the Course. Letter Grades (Clause **Error! Reference source not found.** of Academic Regulations) 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.

12.5 Assessment Components and Weightage

Table : 1

Table 1: Assessment Components and Weightage for different category of Courses		
Nature of Course and Structure	**Evaluation Component**	**Weightage**
Lecture-based Course L component in the L-T-P Structure is predominant (more than 1) (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 P component in the L-T-P Structure is predominant (Examples: 0-0-4; 1-0-4; 1-0-2; etc.)	Continuous Assessments	75%
	End Term Examination	25%
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–T–P) [NTCC], but with assigned Credits (as defined in Clause 5.2 of the Academic Regulations), the method of evaluation shall be based only on Continuous Assessments. The various components of Continuous Assessments, the distribution of weightage among such components, and the method of evaluation/assessment, shall be as decided and indicated in the Course Plan/PRC. The same shall be approved by the respective DAC.

12.6 Minimum Performance Criteria:

12.6.1 Theory only Course and Lab/Practice Embedded Theory Course

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

a. A student must obtain a minimum of 30% of the total marks/weightage assigned to the End Term Examinations in the concerned Course.

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

12.6.2 Lab/Practice only Course and Project Based Courses

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

12.6.3 A student who fails to meet the minimum performance criteria listed above in a Course shall be declared as "Fail" and given "F" Grade in the concerned Course. For theory Courses, the student shall have to re-appear in the "Make-Up Examinations" as scheduled by the University in any subsequent semester, or, re-appear in the End Term Examinations of the same Course when it is scheduled at the end of the following Semester or Summer Term, if offered. The marks obtained in the Continuous Assessments (other than the End Term Examination) shall be carried forward and be included in computing the final grade, if the student secures the minimum requirements (as per Clause 12.6.1, 12.6.2) in the "Make-Up Examinations" of the concerned Course. Further, the student has an option to re-register for the Course and clear the same in the summer term/ subsequent semester if he/she wishes to do so, provided the Course is offered.

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

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

13.1 The transfer of credits shall be examined and recommended by the Equivalence Committee (Refer **Error! Reference source not found.**) and approved by the Dean - Academics.

13.2 Students may earn credits from other Indian or foreign Universities/Institutions with which the University has an MOU, and that MOU shall have specific provisions, rules and guidelines for transfer of credits. These transferred credits shall be counted towards the minimum credit requirements for the award of the degree.

13.3 Students may earn credits by registering for Online Courses offered by *Study Web of Active Learning by Young and Aspiring Minds* (SWAYAM) and *National Program on Technology Enhanced Learning* (NPTEL), or other such recognized Bodies/ Universities/Institutions as approved by the concerned BOS and Academic Council from time to time. The concerned School/Parent Department shall publish/include the approved list of Courses and the rules and guidelines governing such transfer of credits of the concerned Program from time to time. The Rules and Guidelines for the transfer of credits specifically from the Online Courses conducted by SWAYAM/ NPTEL/ other approved MOOCs are as stated in the following Sub-Clauses:

13.3.1 A student may complete SWAYAM/NPTEL/other approved MOOCs as mentioned in Clause 13.3 and transfer equivalent credits to partially or fully complete the mandatory credit requirements of Discipline Elective Courses and/or the mandatory credit requirements of Open Elective Courses as prescribed in the concerned Curriculum Structure. However, it is the sole responsibility of the student to complete the mandatory credit requirements of the Discipline Elective Courses and the Open Elective Courses as prescribed by the Curriculum Structure of the concerned Program.

13.3.2 SWAYAM/NPTEL/ other approved MOOCs as mentioned in Clause 13.3 shall be approved by the concerned Board of Studies and placed (as Annexures) in the concerned PRC.

13.3.3 Parent Departments may release a list of SWAYAM/NPTEL/other approved MOOCs for Pre-Registration as per schedule in the Academic Calendar or through University Notification to this effect.

13.3.4 Students may Pre-Register for the SWAYAM/NPTEL/other approved MOOCs in the respective Departments and register for the same Courses as per the schedule announced by respective Online Course Offering body/institute/ university.

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

13.3.6 SWAYAM/NPTEL/other approved MOOCs Courses are considered for transfer of credits only if the concerned student has successfully completed the SWAYAM/NPTEL/other approved MOOCs and obtained a certificate of successful/satisfactory completion.

13.3.7 A student who has successfully completed the approved SWAYAM/NPTEL/ other approved MOOCs and wants to avail the provision of transfer of equivalent credits, must submit the original Certificate of Completion, or such similar authorized documents to the HOD concerned, with a written request for the transfer of the equivalent credits. On verification of the Certificates/Documents and approval by the HOD concerned, the Course(s) and equivalent Credits shall forwarded to the COE for processing of results of the concerned Academic Term.

13.3.8 The credit equivalence of the SWAYAM/NPTEL/other approved MOOCs are based on Course durations and/or as recommended by the Course offering body/institute/university. The Credit Equivalence mapped to SWAYAM/ NPTEL approved Courses based on Course durations for transfer of credits is summarised in Table shown below. The Grade will be calculated from the marks received by the Absolute Grading Table **Error! Reference source not found.**.

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

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

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

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

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

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

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

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

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

PART B: PROGRAM STRUCTURE

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

The B.Tech. (Robotics and Artificial Intelligence Engineering) Program Structure (2025-2029) totalling 160 credits. 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: B.Tech. (Robotics and Artificial Intelligence Engineering) 2025-2029: Summary of Mandatory Courses and Minimum Credit Contribution from various Baskets

Sl. No.	Baskets	Credit Contribution
1	Humanities and Social Sciences including Management Courses (HSMC)	10
2	Basic Science Courses (BSC)	24
3	Engineering Science Courses (ESC)	22
4	Professional Core Courses (PCC)	64
5	Professional Elective Courses (PEC)	18
6	Open Elective Courses (OEC)	6
7	Project Work (PRW)	16

Table 3: B.Tech. (Robotics and Artificial Intelligence Engineering) 2025-2029: Summary of Mandatory Courses and Minimum Credit Contribution from various Baskets		
Sl. No.	**Baskets**	**Credit Contribution**
8	Mandatory Courses (MAC)	0
	Total Credits	**160**

In the entire Program, the practical and skill based course component contribute to an extent of approximately 58% out of the total credits of 160 for B.Tech. (Robotics and Artificial Intelligence Engineering) program of four years duration.

15. Minimum Total Credit Requirements of Award of Degree

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

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

16.1 The award of the Degree shall be recommended by the Board of Examinations and approved by the Academic Council and Board of Management of the University**.**

16.2 A student shall be declared to be eligible for the award of the concerned Degree if she/he:

a. Fulfilled the Minimum Credit Requirements and the Minimum Credits requirements under various baskets;

b. Secure a minimum CGPA of 4.50 in the concerned Program at the end of the Semester/Academic Term in which she/he completes all the requirements for the award of the Degree as specified in Sub-Clause a of Academic Regulations**;**

c. No dues to the University, Departments, Hostels, Library, and any other such Centers/ Departments of the University; and

d. No disciplinary action is pending against her/him.

PART C: CURRICULUM STRUCTURE

17. Curriculum Structure – Basket Wise Course List

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

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

Table 3.1 : List of Humanities and Social Sciences including Management Courses (HSMC)

Sl. No.	Course Code	Course Name	L	T	P	Credits	Contact Hours	Type of Skill	Pre-requisite
1	ENG1900	English for Technical Communication	2	0	0	2	2	S	-
2	DES1146	Introduction to Design Thinking	1	0	0	1	1	F	-
3	ENG2501	Advanced English	2	0	0	2	2	S	-
4	FIN1002	Essentials of Finance	3	0	0	3	3	S	-

5	APT4005	Aptitude for Employability	0	0	2	1	2	AT	-
6	PPS3018	Preparedness for Interview	0	0	2	1	2	SS	-
		TOTAL	**8**	**0**	**4**	**10**	**12**		

Table 3.2 : List of Basic Science Courses (BSC)

Sl. No.	Course Code	Course Name	L	T	P	Credits	Contact Hours	Type of Skill	Pre-requisite
1	MAT2301	Calculus and Differential Equations	3	1	0	4	4	F	-
2	PHY2501	Optoelectronics and Quantum Physics	3	0	0	3	3	F	-
3	PHY2504	Optoelectronics and Quantum Physics Lab	0	0	2	1	2	F	-
4	MAT2402	Probability and Statistics	3	1	0	4	4	F	-
5	CHE2501	Chemistry of Smart Materials	3	0	0	3	3	S	-
6	CHE2502	Chemistry of Smart Materials Lab	0	0	2	1	2	S	-
7	MAT2303	Linear Algebra and Vector Calculus	3	1	0	4	4	EM	-
8	MAT2404	Discrete Mathematics	3	1	0	4	4	F	-
		TOTAL	**18**	**4**	**4**	**24**	**26**		

Table 3.3 : List of Engineering Science Courses (ESC)

Sl. No.	Course Code	Course Name	L	T	P	Credits	Contact Hours	Type of Skill	Pre-requisite
1	MEC1006	Engineering Graphics	2	0	0	2	2	S	-
2	CSE1500	Computational Thinking using Python	2	0	2	3	4	S	-
3	ECE2022	Digital Design	2	0	0	2	2	F/S	-
4	ECE2052	Digital Design Lab	0	0	2	1	2	F/S	-
5	CIV1200	Foundations of Integrated Engineering	2	0	0	2	2	S	-

6	EEE1200	Basics of Electrical and Electronics Engineering	3	0	0	3	3	F/S	-
7	EEE1250	Basics of Electrical and Electronics Engineering Lab	0	0	2	1	2	F/S	-
8	ECE1511	Design Workshop	1	0	2	2	3	S/EM	-
9	CSE2264	Essentials of AI	3	0	0	3	3	S/EM	-
10	CSE2265	Essentials of AI Lab	0	0	2	1	2	S/EM	-
11	CSE2274	Competitive Programming and Problem Solving	0	0	4	2	4	S/EM	-
		TOTAL	**15**	**0**	**14**	**22**	**29**		

Table 3.4 : List of Program Core Courses

Sl. No.	Course Code	Course Name	L	T	P	C	Contact Hours	Type of Skills	Pre-requisites
1	CSE2200	Problem Solving using C	2	0	0	2	2	S	-
2	CSE2201	Problem Solving using C Lab	0	0	4	2	4	S	-
3	CSE2251	Data Communication and Computer Networks	3	0	0	3	3	S	-
4	CSE2278	Data Structures and Algorithms	3	1	0	4	4	S	-
5	CSE2279	Data Structures and Algorithms Lab	0	0	2	1	2	S	-
6	CSE2255	Object Oriented Programming Using Java	3	0	0	3	3	S/EM	-
7	CSE2256	Object Oriented Programming Using Java Lab	0	0	2	1	2	S/EM	-
8	ECE2530	Embedded Systems using Micro Controllers	3	0	0	3	3	S	-
9	ECE2531	Embedded Systems using Micro Controllers Lab	0	0	2	1	2	S	-
10	MEC3420	Introduction to Robotics and Automation	3	0	0	3	3	S	-
11	CAI2500	Machine Learning	3	0	0	3	3	S/EM	-
12	CAI2501	Machine Learning Lab	0	0	4	2	4	S/EM	-
13	CAI2502	Deep Learning	3	0	0	3	3	S/EM	-
14	CAI2503	Deep Learning Lab	0	0	4	2	2	S/EM	-
15	RAI2004	IoT and Automation	2	0	0	2	2	S/EM	-
16	RAI2005	IoT and Automation Lab	0	0	2	1	2	S/EM	-
17	EEE2509	Control Systems for Robotics	3	0	0	3	3	S/EM	-
18	EEE2566	Control Systems for Robotics Lab	0	0	2	1	2	S/EM	-
19	EEE2511	Sensors and Actuators for Robotics	3	0	0	3	3	S/EM	-
20	EEE2510	Electrical Machines and Drives	3	0	0	3	3	S/EM	-
21	EEE2567	Electrical Machines and Drives Lab	0	0	2	1	2	S/EM	-

22	MAT2503	Transform Techniques, Partial Differential Equation and Probability	3	1	0	4	4	S/EM	-
23	MEC2029	Hydraulic and Pneumatic	3	0	0	3	3	S/EM	-
24	RAI2002	Robot Operating System	3	0	0	3	3	S	-
25	RAI2003	Robot Operating System Lab	0	0	2	1	2	S/EM	-
26	ECE2532	Communication Systems for Robotics	3	0	0	3	3	S/EM	-
27	CSE2271	Software Design and Development	3	0	0	3	3	S	-
		TOTAL	**49**	**2**	**26**	**64**	**75**		

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

S. No	Course Code	Course Name	L	T	P	C	Contact Hours	Type of Skills	Pre-requisites
1	CSE7000	Internship	0	0	0	2	0	S/EM	-
2	CSE7100	Mini Project	0	0	0	4	0	S	-
3	CSE7300	Capstone Project	0	0	0	10	0	S/EM	-
		TOTAL	0	0	0	16			

Table 3.6 : List of Mandatory Courses (MAC)

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

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

Practical / Skill based Courses like internship, project work, capstone project, research project / dissertation, and such similar courses, where the pedagogy does not lend itself to a typical L-T-P-C Structure as defined in Clause 5.1 of the Academic Regulations, are simply assigned the number of Credits based on the quantum of work / effort required to fulfill the learning objectives and outcomes prescribed for the concerned Courses. Such courses are referred to as Non-Teaching Credit Courses (NTCC). These Courses are designed to provide students with hands-on experience and skills essential for their professional development. These courses aim to equip students with abilities in problem identification, root cause analysis, problem-solving, innovation, and design thinking through industry exposure and project-based learning. The expected outcomes are first level proficiency in problem solving and design thinking skills to better equip B.Tech. graduates for their professional careers. The method of evaluation and grading for the Practical / Skill based Courses shall be prescribed and approved by the concerned Departmental Academic Committee (refer Annexure A of the Academic Regulations, 2021). The same shall be prescribed in the Course Handout.

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

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

18.1.1 The Internship / In-plant Training / Skill-based Program / IM / RPL shall be conducted in accordance with the Internship Policy prescribed by the University from time to time.

18.1.2 Internship: student shall undergo internship, either in industry / company, academic / research organizations, government bodies, or international institutions. The objective is to provide practical exposure, industry insights, and real-world experience relevant to the student's field of study.

18.1.3 In-plant Training: student shall undergo training / industrial exposure program aimed at providing with practical insights into real-world working environments. The training may be conducted by industries / companies on-campus or through student visits to industries / companies, government bodies / institutions, or technical organizations.

18.1.4 Skill-based Program: student shall undergo a certified skill-based program of 30 hours / 04 weeks. Skill-based program should cater to Skill-Enhancement, Practical Focus, and Career orientation, Complementary to Curriculum or Industry relevant.

18.1.5 International Immersion (IM): student shall undergo IM aimed at providing global exposure through collaborations with foreign universities, industries, or research institutions. The International Immersion may include industry visits, expert interactions, and cultural exchange activities, enhancing students' international outlook, communication skills, and professional readiness.

18.1.6 Recognition of Prior Learning (RPL): student who shall undergo any formally recognize relevant prior work experience, internships, or project-based learning that meet the internship learning outcomes, thereby allowing students to earn internship credit without repeating equivalent practical training.

18.1.7 The number of Internships available for the concerned Academic Term. Further, the available number of Internships / In-plant training / Skill-based Program / IM / RPL shall be awarded to the students by the University on the basis of merit using the CGPA secured by the student and as per the selection criteria. Provided further, the student fulfils the criteria, as applicable, specified by the industry / company, government bodies, academic / research or through certified courses.

18.1.8 A student may opt for Internship / In-plant Training / IM / RPL in an industry / company, government bodies / academic / research institution, international bodies of her / his choice, subject to the condition that the concerned student takes the responsibility to arrange the Internship / In-plant Training / IM / RPL on her / his own. Provided further, that the industry / company, government bodies, academic / research institution national or international offering such Internship / Training confirms to the University that the Internship shall be conducted in accordance with the Program Regulations and Internship Policy of the University / Rubrics.

18.1.9 A student undergoing RPL must submit an application with supporting documents such as experience letters, project reports, employer feedback, certifications, a self-reflection report etc. Application must be submitted before the commencement of the internship semester.

18.1.10 A student selected for an Internship / In-plant Training / Skill-based Program / IM / RPL in an industry / company, government bodies, academic / research institution shall adhere to all the rules and guidelines prescribed in the Internship Policy of the University.

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

18.1 Mini Project Work

A student may opt to do a Mini Project Work for a period of 6-8 weeks in an Industry / Company or academic / research institution or the University Department(s) during the 5th / 6th / 7th Semester as applicable, subject to the following conditions:

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

18.2.2 The student may do the mini project work in an Industry / Company or academic / research institution of her / his choice subject to the above mentioned condition (Sub-Clause 18.2.1). Provided further, that the Industry / Company or academic / research institution offering such mini project work confirms to the University that the mini project work will be conducted in accordance with the Program Regulations and requirements of the University.

18.2 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 7th / 8th Semester as applicable, subject to the following conditions:

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

18.3.2 The selection criteria (minimum CGPA, pass in all Courses as on date, and any other qualifying criteria) as applicable / stipulated by the concerned Industry / Company or academic / research institution for award of the Capstone Project to a student;

18.3.3 Further, the available number of Capstone Project shall be awarded to the students by the University on the basis of merit using the CGPA secured by the student. Provided further, the student fulfils the criteria, as applicable, specified by the Industry / Company or academic / research institution providing the Capstone Project, as stated in Sub-Clause 18.3.2 above.

18.3.4 A student may opt for Capstone Project in an Industry / Company or academic / research institution of her / his choice, subject to the condition that the concerned student takes the responsibility to arrange the 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.

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

18.3 Research Project / Dissertation

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

18.3.1 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.

19. List of Professional Elective Courses under various Specialisations / Stream Basket

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

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

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

Sl.No	Course Code	Course Name	L	T	P	C	Contact Hour	Type of Skill	Prerequisite	Type of course
Specialization Track 1: Emerging AI and Computational Intelligence										
1	CAI3400	Image Processing and Analysis	2	0	2	3		S/EM	CSE2264	PEC
2	CAI3401	Big Data Analytics for AI	2	0	2	3		S/EM	CSE2264	PEC
3	CAI3402	Optimization Techniques for Machine Learning	2	0	2	3		S/EM	CSE2264	PEC
4	CAI3403	Deep Reinforcement Learning	2	0	2	3		S/EM	CSE2264	PEC
5	CAI3404	AI in Cybersecurity	2	0	2	3		S/EM	CSE2264	PEC
6	CAI3405	Explainable AI	2	0	2	3		S/EM	CSE2264	PEC
7	CAI3406	Responsible AI	2	0	2	3		S/EM	CSE2264	PEC

8	CAI3407	Agentic AI	2	0	2	3		S/EM	CSE2264	PEC
9	CAI3408	Deep Neural Networks	2	0	2	3		S/EM	CSE2264	PEC
10	CAI3409	Speech Recognition and Synthesis	2	0	2	3		S/EM	CSE2264	PEC
11	CAI3410	AI Chatbots without Programming	2	0	2	3		S/EM	CSE2264	PEC
12	CAI3411	Generative AI	2	0	2	3		S/EM	CSE2264	PEC
13	CAI3412	Machine Learning for Finance	2	0	2	3		S/EM	CSE2264	PEC
		TOTAL				12				
Specialization Track 2: AI driven Autonomous Systems										
1	CAI3413	Industrial IoT	2	0	2	3		S/ EM	CSE2264	PEC
2	CAI3414	Smart Farming	2	0	2	3		S/ EM	CSE2264	PEC
3	CAI3415	AI for Autonomous Systems	2	0	2	3		S/ EM	CSE2264	PEC
4	CAI3416	Edge Computing	2	0	2	3		S/ EM	CSE2264	PEC
5	CAI3417	Cognitive Computing	2	0	2	3		S/ EM	CSE2264	PEC
6	CAI3418	Geospatial Data Analytics	2	0	2	3		S/ EM	CSE2264	PEC
7	CAI3419	AI for energy consumption optimization	2	0	2	3		S/ EM	CSE2264	PEC
		TOTAL				**12**				
Specialization Track 3: Healthcare Data Analytics										
1	CAI3420	Bio Medical Informatics	2	0	2	3		S/ EM	CSE2264	PEC
2	CAI3421	Intelligent system for disease prediction and drug discovery	2	0	2	3		S/ EM	CSE2264	PEC
3	CAI3422	AI for Medical Imaging	2	0	2	3		S/ EM	CSE2264	PEC
4	CAI3423	Genomic Data Science	2	0	2	3		S/ EM	CSE2264	PEC
5	CAI3424	Clinical Data Science	2	0	2	3		S/ EM	CSE2264	PEC
6	CAI3425	AI in Epidemiology and Public Health Analytics	2	0	2	3		S/ EM	CSE2264	PEC
7	CAI3426	Time Series Analysis for Patient Monitoring	2	0	2	3		S/ EM	CSE2264	PEC
		TOTAL				**12**				
Specialization Track 4:Intelligent Systems and Automation										

1	RAI3400	Advanced Automation Design and Development	2	0	2	3		S/ EM	RAI2000	PEC
2	RAI3401	Business Analysis with Automation Solutions	2	0	2	3		S/ EM	RAI2000	PEC
3	RAI3402	AI for IoT Applications	2	0	2	3		S/ EM	CSE2264	PEC
4	RAI3403	AI for Robotics	2	0	2	3		S/ EM	CSE2264	PEC
5	RAI3404	Robotic System Design	2	0	2	3		S/ EM	CSE2264	PEC
6	RAI3405	Graph Theory Algorithms for Robotics	3	0	0	3		S/ EM	CSE2264	PEC
7	RAI3406	Robot Perception and Control	2	0	2	3		S/ EM	CSE2264	PEC
8	RAI3407	Autonomous Systems and Path Planning	2	0	2	3		S/ EM	CSE2264	PEC
9	RAI3408	Swarm Intelligence	2	0	2	3		S/ EM	CSE2264	PEC
10	RAI3409	Humanoid Robots	2	0	2	3		S/ EM	CSE2264	PEC
11	MEC3411	Robotics	3	0	0	3		S/ EM	.-	PEC
12	EEE3015	Industrial Automation with PLC and SCADA	3	0	0	3		S/ EM	EEE1200	PEC
TOTAL						**12**				

Track - 5 Special Track

Sl.No	Course Code	Course Name	L	T	P	C	Contact Hours	Type of Skill	Prerequisite	Type of course
1	CAI3427	Language Models for Text Mining	2	0	2	3	3	S/ EM	CSE2264	PEC
2	CAI3428	Practical Deep Learning with TensorFlow	2	0	2	3	3	S/ EM	CSE2264	PEC
3	CAI3429	Deep Learning Techniques for Computer Vision	2	0	2	3	3	S/ EM	MAT2402	PEC
4	CSE3426	Front End Full Stack Development	2	0	2	3	3	S/ EM	CSE2258	PEC
5	CSE3427	Java Full Stack Development	2	0	2	3	3	S/ EM	CSE2258	PEC
6	CSE3428	.Net Full Stack Development	2	0	2	3	3	S/ EM	CSE2258	PEC

Track -6 Mandatory Non-Credited Course (Offered for Lateral Entry students in higher semester wherever applicable in MOOC mode)**

LAW7601	Indian Constitution **	0	0	0	0	-	F	Nil
CHE7601	Environmental Studies **	0	0	0	0	-	F	Nil

CIV7601	Universal Human Values and Ethics **	0	0	0	0	-	F	Nil
PPS1025	Industry Readiness Program - I	0	0	2	0	2	SS	Nil
PPS1026	Industry Readiness Program – II	0	0	2	0	2	SS	Nil
APT4002	Introduction to Aptitude	0	0	2	0	2	AT	Nil
APT4004	Aptitude Training - Intermediate	0	0	2	0	2	AT	Nil
APT4006	Logical and Critical Thinking	0	0	2	0	2	AT	Nil
***Mandatory for Students selected for Tech Mahindra and Capgemini**								
**** Offered for Lateral Entry students in higher semester wherever applicable in MOOC mode**								
+Mandatory for Students Selected for Samsung Innovation Campus								

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

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

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

21.List of MOOC Courses

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

21.1.1. The student needs to study and complete School Core and Program Core Courses in offline mode only.

21.1.2. Massive Open Online Course (MOOC) courses maybe given for Open Elective and Discipline Elective Courses. These courses need to be approved by the concerned BOS and Academic Council from time to time.

21.1.3. SWAYAM/NPTEL/ other approved MOOCs shall be approved by the concerned Board of Studies and placed in the concerned PRC.

21.1.4. Student shall register for these courses in the ERP of Presidency University.

21.1.5. For these MOOC courses faculty coordinators are identified. These faculty should have undergone similar MOOC courses and therefore should be familiar with the mode of class conduction, types of assessments and evaluation procedures.

21.1.6. Study materials shall be provided to the students as video lectures shared by the MOOCs Coordinator(s), or the students may access the approved MOOCs Portal directly. The mode of class conduction is determined by the MOOCs coordinator(s) as detailed in the Course Catalogue and Course Plan.

21.1.7. The question paper shall be prepared by the MOOCs coordinator(s).

21.1.8. Students write the exams in online mode. These exams are scheduled and conducted by the School.

21.1.9. Results are evaluated by School and given to the Office of the Controller of Examinations (CoE).

21.1.10. The details of the duration, credits and evaluation are given below:

Sl#	Duration	Credits
1.	12 weeks	3
2.	8 weeks	2
3	4 weeks	1

21.2 List of MOOC – B.Tech - Robotics and Artificial Intelligence

Table 3.9: MOOC Discipline Elective Courses				
Sl.No	**Course Code**	**Course Name**	**Credits**	**L-T-P-C**
1	CSE3111	Artificial Intelligence: Search Methods for Problem Solving	3	3-0-0-3
2	CSE3112	Privacy and Security in Online Social Media	3	3-0-0-3
3	CSE3113	Computational Complexity	3	3-0-0-3
4	CSE3114	Deep Learning for Computer Vision	3	3-0-0-3
5	CSE3115	Learning Analytics Tools	3	3-0-0-3
6	CSE505	The Joy of Computing Using Python	3	3-0-0-3
7	CSE3119	Coding Skills in Python	3	3-0-0-3
8	CSE3121	Parallel Computer Architecture	3	3-0-0-3
9	CSE3124	Games and Information	3	3-0-0-3
10	CSE3140	Introduction to Industry 4.0 and Industrial Internet of Things	3	3-0-0-3
11	CSE3142	Affective Computing	3	3-0-0-3
12	CSE3196	Foundations of Cyber Physical Systems	3	3-0-0-3
13	CSE3197	Getting Started with Competitive Programming	3	3-0-0-3
14	CSE3198	GPU Architectures and Programming	3	3-0-0-3
15	CSE3199	Artificial Intelligence: Knowledge Representation and Reasoning	3	3-0-0-3
16	CSE3200	Programming in Modern C++	3	3-0-0-3
17	CSE3201	Circuit Complexity Theory	3	3-0-0-3
18	CSE3202	Basics of Computational Complexity	3	3-0-0-3
19	CSE3212	Introduction to Computer and Network Performance Analysis using Queuing	1	1-0-0-1

20	CSE3213	C Programming and Assembly Language	1	1-0-0-1
21	CSE3214	Python for Data Science	1	1-0-0-1
22	CSE3215	Software Conceptual Design	1	1-0-0-1
23	CSE3117	Industrial Digital Transformation	3	3-0-0-3
24	CSE3118	Blockchain for Decision Makers	3	3-0-0-3
25	CSE3349	Technology for Lawyers	3	3-0-0-3
26	CSE3430	Deep Learning for Natural Language Processing	3	3-0-0-3
27	CSE3431	Machine Learning for Engineering and Science Applications	3	3-0-0-3
28	CSE3432	Algorithms in Computational Biology and Sequence Analysis	3	3-0-0-3
29	CSE3433	Introduction to Large Language Models (LLMs)	3	3-0-0-3
30	CSE3434	Quantum Algorithms and Cryptography	3	3-0-0-3
31	CAI3430	Responsible & Safe AI Systems	3	3-0-0-3
32	CCS3416	Practical Cyber Security for Cyber Security Practitioners	3	3-0-0-3
33	IST3409	Design & Implementation of Human-Computer Interfaces	3	3-0-0-3

21.3 MOOC - Open Elective Courses for B. Tech - Robotics and Artificial Intelligence

Table 3.10: MOOC Open Elective Courses

Courses duration is 4 weeks (01 credit)/ 8 weeks (02 credits)/ 12 weeks (03 credits)

Sl. No.	Course Code	Course Name	Total Credits	L-T-P-C
1	BBA2022	Supply Chain digitization	3	3-0-0-3
2	BBA2021	E Business	3	3-0-0-3
3	BBB2016	Business Analytics for Management Decisions	3	3-0-0-3
4	BBB2015	Artificial Intelligence for Investments	3	3-0-0-3
5	MEC3001	Design and Development of Product	1	1-0-0-1
6	ENG3004	Perspectives of Neurolinguistics	1	1-0-0-1
7	PPS4009	Working in Contemporary Teams	1	1-0-0-1
8	MGT3001	Data Analysis and Decision Making	3	3-0-0-3
9	MEC3001	Design and Development of Product	1	1-0-0-1
10	EEE3105	Microsensors and Nanosensors	3	3-0-0-3
11	CIV3065	Drone Systems and Cont¯rol	3	3-0-0-3
12	ECE3183	Neural Networks for Signal Processing – I	3	3-0-0-3
13	CIVXXXX	Disaster Management	3	3-0-0-3

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

Semester Wise Course Grids/ Tables: First year - CYCLE 1

Sl. No.	Course Code	Course Name	L	T	P	C	Contact Hours	Type of Skill/ Focus	Course Caters to	Basket
	Semester 1 - Physics Cycle									
1	MAT2301	Calculus and Differential Equations	3	1	0	4	4	F		BSC
2	PHY2501	Optoelectronics and Quantum Physics	3	0	0	3	3	F		BSC
3	MEC1006	Engineering Graphics	2	0	0	2	2	S		ESC
4	ENG1900	English for Technical Communication	2	0	0	2	2	S		HSMC
5	CSE1500	Computational Thinking using Python	2	0	2	3	4	S		ESC
6	ECE2022	Digital Design	2	0	0	2	2	F/S		ESC
7	DES1146	Introduction to Design Thinking	1	0	0	1	1	F		HSMC
8	PHY2504	Optoelectronics and Quantum Physics Lab	0	0	2	1	2	F		BSC
9	PPS1025	Industry Readiness Program – I	0	0	2	0	2	S		MAC
10	ECE2052	Digital Design Lab	0	0	2	1	2	F/S		ESC
		TOTAL	**15**	**1**	**8**	**19**	**24**			
	Semester 2 – Chemistry Cycle									
1	MAT2402	Probability and Statistics	3	1	0	4	4	F		BSC
2	CHE7601	Environmental Studies	0	0	0	0	0	F		MAC
3	CIV1200	Foundations of Integrated Engineering	2	0	0	2	2	S		ESC
4	CHE2501	Chemistry of Smart Materials	3	0	0	3	3	S		BSC
5	CSE2200	Problem Solving using C	2	0	0	2	2	S		PCC

6	ENG2501	Advanced English	2	0	0	2	2	S		HSMC
7	EEE1200	Basics of Electrical and Electronics Engineering	3	0	0	3	3	F/S		ESC
8	LAW7601	Indian Constitution	0	0	0	0	0	F		MAC
9	CSE2201	Problem Solving using C Lab	0	0	4	2	4	S		PCC
10	CHE2502	Chemistry of Smart Materials Lab	0	0	2	1	2	S		BSC
11	PPS1026	Industry Readiness Program – II	0	0	2	0	2	S		MAC
12	EEE1250	Basics of Electrical and Electronics Engineering Lab	0	0	2	1	2	F/S		ESC
13	ECE1511	Design Workshop	1	0	2	2	3	S/EM		ESC
		TOTAL	**16**	**1**	**12**	**22**	**29**			

First year - CYCLE 2

Sl. No.	Course Code	Course Name	L	T	P	C	Contact Hour	Type of Skill/ Focus	Course Caters to	Basket
	Semester 1 - Chemistry Cycle									
1	MAT2402	Probability and Statistics	3	1	0	4	4	F		BSC
2	CHE7601	Environmental Studies	0	0	0	0	0	F		MAC
3	CIV1200	Foundations of Integrated Engineering	2	0	0	2	2	S		ESC
4	CHE2501	Chemistry of Smart Materials	3	0	0	3	3	S		BSC
5	CSE2200	Problem Solving using C	2	0	0	2	2	S		PCC
6	ENG2501	Advanced English	2	0	0	2	2	S		HSMC
7	EEE1200	Basics of Electrical and Electronics Engineering	3	0	0	3	3	F/S		ESC
8	LAW7601	Indian Constitution	0	0	0	0	0	F		MAC
9	CSE2201	Problem Solving using C Lab	0	0	4	2	4	S		PCC
10	CHE2502	Chemistry of Smart Materials Lab	0	0	2	1	2	S		BSC
11	PPS1026	Industry Readiness Program – II	0	0	2	0	2	S		MAC

12	EEE1250	Basics of Electrical and Electronics Engineering Lab	0	0	2	1	2	F/S		ESC
13	ECE1511	Design Workshop	1	0	2	2	3	S/EM		ESC
		TOTAL	**16**	**1**	**12**	**22**	**29**			
	Semester 2 – Physics Cycle									
1	MAT2301	Calculus and Differential Equations	3	1	0	4	4	F		BSC
2	PHY2501	Optoelectronics and Quantum Physics	3	0	0	3	3	F		BSC
3	MEC1006	Engineering Graphics	2	0	0	2	2	S		ESC
4	ENG1900	English for Technical Communication	2	0	0	2	2	S		HSMC
5	CSE1500	Computational Thinking using Python	2	0	2	3	4	S		ESC
6	ECE2022	Digital Design	2	0	0	2	2	F/S		ESC
7	DES1146	Introduction to Design Thinking	1	0	0	1	1	F		HSMC
8	PHY2504	Optoelectronics and Quantum Physics Lab	0	0	2	1	2	F		BSC
9	PPS1025	Industry Readiness Program – I	0	0	2	0	2	S		MAC
10	ECE2052	Digital Design Lab	0	0	2	1	2	F/S		ESC
		TOTAL	**15**	**1**	**8**	**19**	**24**			
Semester 3										
1	MAT2303	Linear Algebra and Vector Calculus	3	1	0	4	4	EM		BSC
2	CSE2251	Data Communication and Computer Networks	3	0	0	3	3	S		PCC
3	CSE2278	Data Structures and Algorithms	3	1	0	4	4	S		PCC
4	CSE2279	Data Structures and Algorithms Lab	0	0	2	1	2	S		PCC
5	CSE2255	Object Oriented Programming Using Java	3	0	0	3	3	S/EM		PCC
6	CSE2256	Object Oriented Programming Using Java Lab	0	0	2	1	2	S/EM		PCC
7	ECE2530	Embedded Systems using Micro Controllers	3	0	0	3	3	S		PCC

8	ECE2531	Embedded Systems using Micro Controllers Lab	0	0	2	1	2	S		PCC
9	MEC3420	Introduction to Robotics and Automation	3	0	0	3	3	S		PCC
10	APT4002	Introduction to Aptitude	0	0	2	0	2	AT		MAC
11	CIV7601	Universal Human Values and Ethics	0	0	0	0	0	S		MAC
		TOTAL	**18**	**2**	**8**	**23**	**28**			
Semester 4										
1	MAT2404	Discrete Mathematics	3	1	0	4	4	F		BSC
2	CAI2500	Machine Learning	3	0	0	3	3	S/EM		PCC
3	CAI2501	Machine Learning Lab	0	0	4	2	4	S/EM		PCC
4	RAI2004	IoT and Automation	2	0	0	2	2	S/EM		PCC
5	RAI2005	IoT and Automation Lab	0	0	2	1	2	S/EM		PCC
6	EEE2509	Control Systems for Robotics	3	0	0	3	3	S/EM		PCC
7	EEE2566	Control Systems for Robotics Lab	0	0	2	1	2	S/EM		PCC
8	CSE2264	Essentials of AI	3	0	0	3	3	S/EM		ESC
9	CSE2265	Essentials of AI Lab	0	0	2	1	2	S/EM		ESC
10	APT4004	Aptitude Training – Intermediate	0	0	2	0	2	AT		MAC
11	FIN1002	Essentials of Finance	3	0	0	3	3	S		HSMC
		TOTAL	**17**	**1**	**12**	**23**	**30**			
Semester 5										
1	EEE2511	Sensors and Actuators for Robotics	3	0	0	3	3	S/EM		PCC
3	EEE2510	Electrical Machines and Drives	3	0	0	3	3	S/EM		PCC
4	EEE2567	Electrical Machines and Drives Lab	0	0	2	1	2	S/EM		PCC
5	MAT2503	Transform Techniques, Partial Differential Equation and Probability	3	1	0	4	4	S/EM		PCC
6	MEC2029	Hydraulic and Pneumatic	3	0	0	3	3	S/EM		PCC
7	RAI2002	Robot Operating System	3	0	0	3	3	S		PCC
8	RAI2003	Robot Operating System Lab	0	0	2	1	2	S/EM		PCC
9	CSEXXXX	Professional Elective – I	3	0	0	3	3	S/EM		PEC

10	CSE7000	Internship	0	0	0	2	0	S/EM		PRW
11	APT4006	Logical and Critical Thinking	0	0	2	0	2	AT		MAC
12	CAI2502	Deep Learning	3	0	0	3	3	S/EM		PCC
13	CAI2503	Deep Learning Lab	0	0	4	2	2	S/EM		PCC
		TOTAL	**21**	**1**	**10**	**28**	**32**			
Semester 6										
1	ECE2532	Communication Systems for Robotics	3	0	0	3	3	S/EM		PCC
2	CSE2271	Software Design and Development	3	0	0	3	3	S		PCC
3	CSE2274	Competitive Programming and Problem Solving	0	0	4	2	4	S/EM		ESC
4	CSEXXXX	Professional Elective – II	3	0	0	3	3	S		PEC
5	CSEXXXX	Professional Elective – III	3	0	0	3	3	S		PEC
6	XXXXXXX	Open Elective – I	3	0	0	3	3	S		OEC
7	APT4005	Aptitude for Employability	0	0	2	1	2	AT		HSMC
		TOTAL	**15**	**0**	**6**	**18**	**21**			
Semester 7										
1	CSEXXXX	Professional Elective – IV	3	0	0	3	3	S		PEC
2	CSEXXXX	Professional Elective – V	3	0	0	3	3	S		PEC
3	CSEXXXX	Professional Elective – VI	3	0	0	3	3	S		PEC
4	XXXXXXX	Open Elective – II	3	0	0	3	3	S		OEC
5	PPS3018	Preparedness for Interview	0	0	2	1	2	SS		HSMC
6	CSE7100	Mini Project	0	0	0	4	0	S		PRW
		TOTAL	**12**	**0**	**2**	**17**	**14**			
Semester 8										
1	CSE7300	Capstone Project	0	0	0	10	0	S/EM		PRW
		TOTAL	**0**	**0**	**0**	**10**	**0**			

23.Course Catalogue

Course Catalogue of all Courses Listed including the Courses Offered by other School / Department and Discipline / Programme Electives – Course Code, Course Name, Prerequisite, Anti-requisite, Course Description, Course Outcome, Course Content (with Blooms Level, CO, No. of Contact Hours), Reference Resources.

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

Course Code: MAT2301	Course Title: Calculus and Differential Equations Type of Course: BSC – Theory			L-T- P- C	3	1	0	4
Version No.	2.0							
Course Pre-requisites	NIL							
Anti-requisites	NIL							
Course Description	The course focuses on the concepts of calculus and linear algebra with reference to specific engineering problems. The course is of both conceptual and analytical type in nature.							
Course Objective	The objective of the course is to familiarize the learners with the concepts of "CALCULUS AND LINEAR ALGEBRA" and attain Skill Development through problem solving techniques.							
Course Out Comes	On successful completion of the course the students shall be able to: 1) Comprehend the knowledge of applications of matrix principles. 2) Understand the concept of partial derivatives and their applications. 3) Apply the principles of integral calculus to evaluate integrals. 4) Adopt the various analytical methods to solve differential equations.							
Course Content:								
Module 1	Linear Algebra				16 Classes			
Review: Types of matrices, elementary transformations, Linear Algebra: Echelon form, rank of a matrix, consistency and solution of system of linear equations - Gauss elimination method, Gauss-Jordan method. Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley-Hamilton theorem – Diagonalization of matrices –								

<table>
<tr><td colspan="6">Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

Engineering Applications of Linear Algebra.</td></tr>
<tr><td>Module 2</td><td>Partial Derivatives</td><td></td><td></td><td></td><td>14 CLASSES</td></tr>
<tr><td colspan="6">Review: Differential calculus with single variable.

Differential Calculus:

Partial differentiation, Homogeneous functions and Euler‵s theorem, Total derivative, Change of variables, Jacobians, Partial differentiation of implicit functions, Taylor‵s series for functions of two variables, Maxima and minima of functions of two variables, Lagrange‵s method of undetermined multipliers.

Engineering Applications of partial derivatives.</td></tr>
<tr><td>Module 3</td><td>Integral calculus</td><td></td><td></td><td></td><td>12 Classes</td></tr>
<tr><td colspan="6">Review: Integral calculus for single integrals.

Integral calculus:

Multiple Integrals- Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves, evaluation of triple integrals-change of variables between Cartesian and cylindrical and spherical polar co-ordinates.

Beta and Gamma functions–inter-relation-evaluation of integrals using gamma and beta functions. Evaluate double & triple integrals.</td></tr>
<tr><td>Module 4</td><td>Differential Equations</td><td>Assignment</td><td></td><td>Programming</td><td>18 Classes</td></tr>
<tr><td colspan="6">Definition, types of differential equations, order and degree, Linear Differential Equations, Bernoulli’s Differential Equation, Exact and Non - Exact Differential Equations.

Higher order Differential Equation with constant coefficients and with right hand side of the form eax, sinax, cosax, eaxf(x), xnf(x) etc., Linear equations with variable coefficients such as Cauchy Equation and Lagrange’s Equation, Method of Variation of Parameters.

Engineering applications of differential equations.</td></tr>
<tr><td colspan="6">Targeted Application & Tools that can be used:

The contents of this course has direct applications in most of the core engineering courses for problem formulations, Problem Solution and system Design.

Tools Used: Python.</td></tr>
<tr><td colspan="6">Assignment:</td></tr>
<tr><td colspan="6">List at least 3 sets of Matrix Applications concerning the respective branch of Engineering and obtain the solution using C Programming/Python.</td></tr>
</table>

Select any one simple differential equation pertaining to the respective branch of engineering, identify the dependent and independent variable – Obtain the solution and compare the solution sets by varying the values of the dependent variable.
Text Book Sankara Rao, Introduction to Partial differential equations, Prentice Hall of India, edition, 2011 B. S. Grewal (2017), Higher Engineering Mathematics by, 44th Edition, Khanna Publishers.
References: Victor Henner, Tatyana Belozerova, Mickhail Khenner, Ordinary and Partial Differential Equations, CRC Press, Edition, 2013. Walter Ledermann, Multiple integrals, Springer, 1st edition Lay, Linear Algebra ansd its applications, 3rd Ed., 2002, Pearson Education India. Erwin Kreyzig, Advanced Engineering Mathematics, John Wiley and sons, Inc.10th Edition MatLab usage manual E-resources/ Web links: 1. https://nptel.ac.in/courses/109104124 2. https://nptel.ac.in/courses/111106051 3. https://nptel.ac.in/courses/111102137 4. https://www.cuemath.com/learn/mathematics/algebra-vs-calculus/ 5. https://stanford.edu/~shervine/teaching/cs-229/refresher-algebra-calculus 6. https://math.hmc.edu/calculus/hmc-mathematics-calculus-online-tutorials/linear-algebra/ 7. https://www.math.hkust.edu.hk/~maqian/ma006_0607F.html 8. https://www.scu.edu.au/study-at-scu/units/math1005/2022/
Topics relevant to SKILL DEVELOPMENT: The course focuses on the concepts of calculus and linear algebra with reference to specific engineering problems. The course is of both conceptual and analytical type in nature. The lab sessions associated with the course are concerned with acquiring an ability to use the MATLAB software. for Skill Development through Experiential Learning methodologies. This is attained through assessment component mentioned in course handout.

Course Code: PHY2501	Course Title: Optoelectronics and Quantum Physics Type of Course: 1] School Core	L-T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	NIL					

<table>
<tr><td>Anti-requisites</td><td colspan="3">NIL</td></tr>
<tr><td>Course Description</td><td colspan="3">The purpose of this course is to enable the students to understand the fundamentals, working and applications of optoelectronic devices and to develop the basic abilities to appreciate the applications of advanced microscopy and quantum computers. The course develops the critical thinking and analytical skills.</td></tr>
<tr><td>Course Out Comes</td><td colspan="3">On successful completion of the course the students shall be able to:

CO1: To understand the concepts of electrical conducting properties of metal, semiconductor and superconductivity.

CO2: To understand the principles of quantum mechanics.

CO3: Discuss the quantum concepts used in quantum computers.

CO4: Explain the applications of lasers and optical fibers in various technological fields.</td></tr>
<tr><td>Course Objective</td><td colspan="3">The objective of the course is to familiarize the learners with the concepts of "Applied Physics for Computer Science Cluster "and to attain the basic knowledge related to quantum mechanics and computation.</td></tr>
<tr><td>Course Content:</td><td colspan="3"></td></tr>
<tr><td>Module 1</td><td>Electrical Conductivity Of Solids And Semiconducting Devices</td><td>Assignment</td><td>11 Sessions</td></tr>
<tr><td colspan="4">Topics: Classification of materials based on bandgap, Fermi energy and Fermi level, Fermi level in semiconductors,

Law of mass action, Electrical conductivity of a semiconductor, Hall effect, Superconductivity, p-n junctions, Zener diode, Solar cells, I-V characteristics, and LEDs</td></tr>
<tr><td>Module 2</td><td>Quantum Mechanics</td><td>Assignment</td><td>11 Sessions</td></tr>
<tr><td colspan="4">Topics: Introduction, de-Broglie hypothesis, Heisenberg's uncertainty principle- statement and physical significance. Wave function-properties and physical significance. Schrodindger's time independent wave equation, Probability density and normalization of wave function. Wave Function in Ket Notation: Matrix form of wave function, Identity operator, Determination of I|0> and I|1>, Pauli Matrices and its operations on 0 and 1 states, Mention of Conjugate and Transpose, Unitary Matrix U, Examples: 2x2 Matrices and their multiplication (Inner Product), Probability, Orthogonality</td></tr>
<tr><td>Module 3</td><td>Quantum Computing</td><td>Term paper</td><td>12 Sessions</td></tr>
<tr><td colspan="4">Topics: Introduction to quantum computing, Moore's law & its end, Differences between classical and quantum computing, Concept of Qubit and its properties, . Representation of qubit by Bloch sphere, Quantum Gates: Single Qubit Gates: Quantum Not Gate, Pauli Z Gate, Hadamard Gate, Phase Gate (or S Gate), T Gate. Multiple Qubit Gates: Controlled gate - CNOT Gate, (Discussion for 4 different input states). Representation of Swap gate, Controlled - Z gate, Toffoli gate. Problems.</td></tr>
<tr><td>Module 4</td><td>Lasers And Optical Fibers</td><td>Term paper</td><td>11 Sessions</td></tr>
<tr><td colspan="4">Topics: Interactions of radiations with matter, expression for energy density of a system under thermal equilibrium in terms of Einstein's coefficients, conditions for LASER action using Einstein's coefficients, Characteristics of laser, conditions and requisites of laser, Principle of optical fibers,</td></tr>
</table>

Numerical aperture and acceptance angle (Qualitative), Attenuation, Applications: Point to point communication with block diagram, application of optical fibers in endoscopy.
Targeted Application & Tools that can be used: Areas of application are optoelectronics industry, Solar panel technologies, quantum computing software, electronic devices using transistors and diodes, memory devices, endoscopy, SQUIDS in MRI, Advanced material characterizations using SEM and STM. Origin, excel and Mat lab soft wares for programming and data analysis.
Project work/Assignment: Mention the Type of Project /Assignment proposed for this course
Assessment Type Midterm exam Assignment (review of digital/ e-resource from PU link given in references section - mandatory to submit screen shot accessing digital resource.) Quiz End Term Exam Self-Learning 1. Prepare a comprehensive report on non-conventional energy resources in Karnataka and their pros and cons. 2. Write a report on importance of quantum entanglement in supercomputers.
Text Book Engineering Physics by Avadhanalu, Revised edition, S. Chand Publications,2024. Quantum Computation and Quantum Information, Michael A. Nielsen & Isaac L. Chuang, Cambridge Universities Press, 2010 Edition
References: 1. Elementary Solid state Physics: Principles and Applications by M.A. Omar, 1st Edition, Pearson Publications, 2002. 2. Principles of Quantum Mechanics by R Shankar, 2nd edition, springer Publications, 2011. 3. Optoelectronics: An Introduction by John Wilson and John Hawkes, 3rd edition, Pearson Publications, 2017. 4. Engineering Physics by Gaur and Gupta, Dhanpat Rai Publications, 2012. 5. Introduction to Quantum Mechanics, David J Griffiths, Cambridge University Press, 2019
E-Resourses: https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=553045&site=ehost-live https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=833068&site=ehost-live

https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=323988&site=ehost-live https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=1530910&site=ehost-live https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=486032&site=ehost-live
Topics relevant to "SKILL DEVELOPMENT": Fundamentals of materials, Lasers and optical fibers. for Skill Development through Participative Learning Techniques. This is attained through the Assignment/ Presentation as mentioned in the assessment component in course handout.

Course Code: MEC1006	Course Title: Engineering Graphics Type of Course: School Core & Theory Only	L- T- P- C	2	0	0	2
Version No.		1.2				
Course Pre-Requisites		NIL				
Anti-requisites		NIL				
Course Description		The course is designed with the objective of giving an overview of engineering graphics. It is introductory in nature and acquaints the students with the techniques used to create engineering drawings. The course emphasizes on projection of points, lines, planes and solids and isometric projections.				
Course Objective		The objective of the course is to familiarize the learners with the concepts of "Engineering Graphics" and attain SKILL DEVELOPMENT through Problem solving methodologies.				
Course Outcomes		On successful completion of this course the students shall be able to: Demonstrate competency of Engineering Graphics as per BIS conventions and standards. Comprehend the theory of projection for drawing projections of Points, Lines and Planes under different conditions. Prepare multiview orthographic projections of Solids by visualizing them in different positions. Prepare pictorial drawings using the principles of isometric projections to visualize objects in three dimensions.				
	Course Content:					

Module 1	Introduction to Drawing	Assignment		Standard technical drawing	7 Sessions

	Topics: Introduction, drawing instruments and their uses, relevant BIS conventions and standards, Lettering, Line conventions, dimensioning, Selection of drawing sheet size and scale. [02 Hours: Comprehension Level]

Module 2	Orthographic projections of	Assignment		Projection methods Analysis	7 Sessions

	Points, Straight Lines and Plane Surfaces			

Topics:

Introduction, Definitions – Elements of projection and methods of projection, Planes of projection, reference line and conventions adopted. First angle and third angle projections. Projection of Points in all 4 quadrants.

Projections of Straight Lines (located in first quadrant/first angle projection only): True and apparent lengths, true and apparent Inclinations to reference planes. (No application problems). Projection of Plane surfaces (First angle projection): Regular plane surfaces – triangle, square, rectangle, pentagon, hexagon and circle – in different positions inclined to both the planes using change of position method only.

[10 Hours: Application Level]

Module 3	Orthographic Projections of Solids	Assignment	Multi-view drawing Analysis	8 Sessions

Topics:

Introduction, Projection of right regular prisms, pyramids, cone, hexahedron and tetrahedron in different positions (Problems resting on HP only and First angle projection).

[10 Hours: Application Level]

Module 4	Isometric Projections of Solids (Using isometric scale only)	Assignment	Spatial Visualization	8 Sessions

Topics:

Introduction, Isometric scale, Isometric projections of right regular prisms, cylinders, pyramids, cones and their frustums, spheres and hemispheres, hexahedron (cube), and combination of 2 solids, conversion of orthographic view to isometric projection of simple objects.

[8 Hours: Application Level]

Text Book:

1.N. D. Bhatt, "Engineering Drawing: Plane and Solid Geometry," Charotar Publishing House Pvt. Ltd.

References: K.R. Gopalakrishna, “Engineering Graphics”, Subhash Publishers, Bangalore. D. M. Kulkarni, A. P. Rastogi, A. K. Sarkar, “Engineering Graphics with AutoCAD,” Prentice Hall. D. A. Jolhe, “Engineering Drawing with Introduction to AutoCAD,” Tata McGraw Hill. Web resources: https://nptel.ac.in/courses/112103019
Topics relevant to “SKILL DEVELOPMENT”: Projection in first and third angle for SKILL DEVELOPMENT through Problem Solving methodologies. This is attained through the assessment component mentioned in the course handout.

Course Code: ENG1900	Course Name: English for Technical Communication	L- T- P- C	2	0	0	2
Version No.						
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	This course enhances the technical communication skills of BTech and BCA students, focusing on clarity, precision, and conciseness in academic and professional settings. Students will learn to differentiate between general and technical communication, analyze technical content, develop structured writing skills, and deliver effective presentations. Through interactive activities such as TED Talk analyses, report writing, and presentation practice, the course provides hands-on experience for real-world applications. By the end, students will be equipped to communicate complex technical information effectively in various professional contexts.					
Course Outcomes	On successful completion of the course the students shall be able to: Differentiate between general and technical communication. Explain key reading comprehension techniques to enhance understanding of technical texts. Write clear, concise, and well-structured technical reports and documents. Deliver technical presentations and implement peer feedback for continuous improvement. Explain ethical practices in digital communication for professional use.					
Course Content: Theory						

Module 1	Technical communication	Quiz	Listening	6 Hours
Introduction to Communication Technical vs. General Communication Characteristics of technical communication Importance of clarity, precision, and objectivity Activity: Watching TED Talks/videos to identify differences in technical and general vocabulary				
Module 2	Technical Reading	Assignment	Reading	6 hours
Reading Comprehension Note making & Notetaking Content Analysis Activity: Reading technical articles and answering comprehension questions Note making techniques				
Module 3	Technical Writing	Assignment	Writing	6 hours
Paragraph Writing Structure of a paragraph (topic sentence, supporting details, coherence) Report Writing Structure of technical and project reports (Introduction, Methods, Results, Discussion) Activity: Writing a structured paragraph on a technical topic Writing project reports				
Module 4	Professional Presentation	Presentation	Speaking	6 Hours
Introduction to Presentation Skills Preparing a Presentation Structuring content (Introduction, Body, Conclusion)				

Designing effective slides (Text. visual aids, readability, and impact) Delivering a Presentation Engagement techniques, Storytelling, narration, pitching ideas handling Q&A Conviction, commitment, generating interest through enthusiasm Demonstration & Practice Giving presentations on topics based on their academic interest Evaluating and providing peer feedback Activity: Analyze a real-world engineering issue and present solutions using a structured approach.				
Module 5	Digital Communication and Ethics	Assignment	Digital Awareness	6 Hours
Introduction to Digital Communication Platforms Influence of Internet Slang, Emojis, and Memes on Language Ethics in Digital Communication Activity: Create a 100-word social media post for a technical topic, focusing on clarity and tone for a general audience.				
Targeted Application & Tools that can be used: ChatGPT, Deep seek, Gemini, YouTube, Instagram, Quill Bot, Grammarly, Padlet				
References: Text books: Gupta, R.C. Technical Communication. 2nd ed., Cambridge University Press, 2021. Lannon, John M., and Laura J. Gurak. Technical Communication. 15th ed., Pearson, 2022. Reference Books: Gerson, Sharon J., and Steven M. Gerson. Technical Communication: Process and Product. 9th ed., Pearson, 2020. Lannon, John M., and Laura J. Gurak. Technical Communication. 15th ed., Pearson, 2022.				

Markel, Mike, and Stuart A. Selber. Technical Communication. 13th ed., Bedford/St. Martin's, 2020.

Reynolds, George. Ethics in Information Technology. 6th ed., Cengage Learning, 2018.

Wempen, Faithe. Digital Literacy for Dummies. Wiley, 2014.

Web Resources:

https://owl.purdue.edu/owl/subject_specific_writing/technical_writing.

https://journals.ieeeauthorcenter.ieee.org/.

https://www.stc.org/.

https://ocw.mit.edu/.https://www.ted.com/talks.

https://owl.purdue.edu/owl/subject_specific_writing/professional_technical_writing/digital_writing.html.

http://www.albion.com/netiquette/.

https://www.unesco.org/en/artificial-intelligence/ethics.

Topics Relevant to "employability": Teamwork and Collaboration, Critical Thinking and Problem-Solving

Topics Relevant to "Human Values and Professional Ethics": Critical reasoning, Inclusivity and Fairness

<table>
<tr><td>Course Code:
CSE1500</td><td>Course Title: Computational Thinking using Python
Type of Course: ESC - Theory</td><td>L- T-P- C</td><td>2</td><td>0</td><td>2</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="6">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="6">NIL</td></tr>
<tr><td>Anti-requisites</td><td colspan="6">NIL</td></tr>
<tr><td>Course Description</td><td colspan="6">The purpose of this course is to enable the students to develop python scripts using its basic programming features and also to familiarize the Python IDLE and other software’s. This course develops analytical skills to enhance the programming abilities. The associated laboratory provides an opportunity to validate the concepts taught and
enhances the ability to build real time applications.</td></tr>
<tr><td>Course Object</td><td colspan="6">The objective of the course is to familiarize the learners with the concepts of Programming in Python and attain Employability through Problem Solving Methodologies.</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">On successful completion of this course the students shall be able to:
Summarize the basic Concepts of python.
Demonstrate proficiency in using data structures.
Illustrate user-defined functions and exception handling.
Identify the various python libraries.</td></tr>
<tr><td>Course Content:</td><td colspan="6"></td></tr>
<tr><td>Module 1</td><td>Basics of Python programming</td><td>Assignment</td><td colspan="3">Programming</td><td>12 Classes</td></tr>
<tr><td colspan="7">Topics: Data types, operators and Expressions, Input and Output Statements. Control Structures – Selective and Repetitive structures</td></tr>
<tr><td>Module 2</td><td>Indexed and Associative Data Structures</td><td>Simple applications</td><td colspan="3">Programming</td><td>11 Classes</td></tr>
<tr><td colspan="7">Topics: Strings, Lists, Sets, Tuples, Dictionaries</td></tr>
</table>

Module 3	Functions, Exception handling and libraries	Case study	Programming	12 Classes
Topics: User defined functions, exception handling, Introduction to python built-in libraries				
Targeted Application & Tools that can be used: Targeted Application: Web application development, AI, Operating systems Tools: Python IDLE, ANACONDA Application Areas: Web Development				

Course Code: ECE2022	Course Title: Digital Design Type of Course: ESC - Theory	L- P- T-C	2	0	0	2
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	The purpose of this course is to enable the students to appreciate the fundamentals of digital logic circuits and Boolean algebra focusing on both combinational and sequential logic circuits. The course emphasizes on minimization techniques for making canonical and low-cost digital circuit implementations. This course deals with analysis and design of digital electronic circuits. The course also creates a foundation for future courses which includes Computer Architecture, Microprocessors, Microcontrollers, and Embedded Systems etc. The course enhances the Design, Implementation and Programming abilities through laboratory tasks. The associated laboratory provides an opportunity to verify the theoretical knowledge.					
Course Objective	The objective of the course is SKILL DEVELOPMENT of the student by using PARTICIPATIVE LEARNING techniques.					
Course Outcomes	On successful completion of this course the students shall be able to: Describe the concepts of number systems, Boolean algebra and logic gates. Apply minimization techniques to simplify Boolean expressions. Demonstrate the Combinational circuits for a given logic					

	Demonstrate the Sequential and programmable logic circuits Implement various combinational and sequential logic circuits using gates.			
Course Content:				
Module 1	Fundamentals of Number systems- Boolean algebra and digital logic	Application Assignment	Data Analysis task	10 classes
Topics: Review of Number systems and logic gates, Number base conversions, Overview of Boolean functions and simplifications, two, three, four variable K-Maps- Don't care conditions- Both SOP and POS- Universal Gates (NAND & NOR) Implementations. Introduction to HDL.				
Module 2	Boolean function simplification	Application Assignment	Data Analysis task	10 Classes
Topics: Introduction to Combinational circuits, Analysis, Design procedure, Binary Adder and Subtractor, Magnitude comparator, Parity generator and checker, Multiplexers-Demultiplexers, Decoders, Encoders and Priority Encoders, HDL Models of combinational circuits.				
Module 3	Combinational Logic circuits:	Application Assignment	Programming Task & Data Analysis task	10 Classes
Topics: Introduction to sequential circuits, Storage elements: latches and flip flops, Characteristic tables and equations, excitation table, Analysis of clocked sequential circuits, Mealy & Moore Models of finite state machines - Registers & Counters. HDL Models of Sequential circuits.				
Text Book(s): Mano, M. Morris and Ciletti Michael D., "Digital Design", Pearson Education, 6th edition Thomas L. Floyd "DIGITAL LOGIC DESIGN" , Pearson Education, fourth edition.				
Reference(s): Reference Book(s): R1. Jain, R. P., "Modern Digital Electronics", McGraw Hill Education (India), 4th Edition R2. Roth, Charles H., Jr and Kinney Larry L., "Fundamentals of logic Design", Cengage Learning, 7th				

Edition

Online Resources (e-books, notes, ppts, video lectures etc.): Book Free Download

(studymaterialz.in)

eBook1: Mano, M. Morris and Ciletti Michael D., “Digital Design”, Pearson Education.

{[PDF] Digital Design By M. Morris Mano, Michael D Ciletti Book Free Download

}

eBook2:Floyd “DIGITAL LOGIC DESIGN” fourth edition- ePub, eBook- [PDF] DIGITAL LOGIC DESIGN FOURTH EDITION FLOYD | abri.engenderhealth.org.

NPTEL Course- NPTEL :: Electrical Engineering - NOC:Digital Electronic Circuits

Digital Logic Design PPT Slide 1 (iare.ac.in)

Lab Tutorial: Multisim Tutorial for Digital Circuits - Bing video

CircuitVerse - Digital Circuit Simulator online

Learn Logisim ➠ Beginners Tutorial | Easy Explanation! - Bing video

Digital Design 5: LOGISIM Tutorial & Demo

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

E-content:

Z. Xin-Li and W. Hong-Ying, "The Application of Digital Electronics in Networking Communication," 2016 Eighth International Conference on Measuring Technology and Mechatronics Automation (ICMTMA), 2016, pp. 684-687, doi: 10.1109/ICMTMA.2016.168.

An encoding technique for design and optimization of combinational logic circuit Dipayan Bhadra;Tanvir Ahmed Tarique;Sultan Uddin Ahmed;Md. Shahjahan;Kazuyuki Murase 2010 13th International Conference on Computer and Information Technology (ICCIT)

A. Matrosova and V. Provkin, "Applying Incompletely Specified Boolean Functions for Patch Circuit Generation," 2021 IEEE East-West Design & Test Symposium (EWDTS), 2021, pp. 1-4, doi: 10.1109/EWDTS52692.2021.9581029.

A. Matrosova, V. Provkin and E. Nikolaeva, "Masking Internal Node Faults and Trojan Circuits in Logical Circuits," 2019 IEEE East-West Design & Test Symposium (EWDTS), 2019, pp. 1-4, doi: 10.1109/EWDTS.2019.8884434.

Topics related to development of “ SKILL DEVELOPMENT ”: Adders, Multiplexers, Decoders / Encoders; Flip-Flops, Counters and Registers.

<table>
<tr><td>Course Code:
DES1146</td><td colspan="3">Course Title: Introduction to Design Thinking
Type of Course: Theory</td><td colspan="2">L-T-P- C</td><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>Version No.</td><td></td><td colspan="8">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td></td><td colspan="8">NIL</td></tr>
<tr><td>Anti-requisites</td><td></td><td colspan="8">NIL</td></tr>
<tr><td>Course Description</td><td></td><td colspan="8">The course aims to introduce students to the fundamental principles and processes of Design Thinking and will learn to apply Design Thinking methodologies to real-world challenges. The course emphasizes empathy, creativity, and collaboration, equipping students with essential skills for successful engineering practice.</td></tr>
<tr><td>Course Objective</td><td></td><td colspan="8">This course is designed to develop and familiarize the learners with the concepts of creating thinking and attain Entrepreneurship by using Participative Learning techniques.</td></tr>
<tr><td>Course Outcomes</td><td></td><td colspan="8">On successful completion of the course the students shall be able to:
Understand the concept and importance of Design Thinking.
Differentiate between traditional problem-solving and Design Thinking.
Identify the core stages of the Design Thinking process.</td></tr>
<tr><td>Course Content:</td><td></td><td colspan="8">All assignments and projects must be developed using the reference materials available from the PU e-resource database – JSTOR, EBSCO, Library OPAC, NPTEL Videos, etc.</td></tr>
<tr><td>Module 1</td><td colspan="2">Introduction to Design Thinking</td><td>Visual journal, book of essays, context-specific assignment/project</td><td></td><td colspan="4">Visual output generation, by Visual Journal and narrative development.</td><td>3 hours</td></tr>
<tr><td></td><td colspan="9">Topic
Definition and Introduction to Design Thinking
Understand the Design Thinking Process</td></tr>
</table>

<table>
<tr><td>Module 2</td><td>Design Thinking in Action</td><td>Visual journal, book of essays, context-specific assignment/project</td><td></td><td>Visual output generation, by visual journal and narrative development.</td><td>12 hours</td></tr>
<tr><td></td><td colspan="5">Topics:

Introduction to the steps of Design Thinking Process

Understand use cases of Design thinking

Design Thinking and Research Tools pertaining to Consumer Tech. , Home Tech. , Personal Tech. , Auto Tech. or Extended Reality.</td></tr>
<tr><td></td><td colspan="5">Targeted Application & Tools that can be used:

Design ideation tools like Miro , SCAMPER etc.

Research Tools for Human Centric Design using forecasting tools like WGSN

Feedback tools like Google Forms , etc.

Expert Lectures</td></tr>
<tr><td></td><td colspan="5">Text Book

Thinking Design by S Balaram. New Delhi [India]: Sage Publications Pvt. Ltd. 2010. eBook., Database: eBook Collection (EBSCOhost)

https://puniversity.informaticsglobal.com:2284/ehost/detail/detail?vid=6&sid=18ab1f43-1f92-4d02-ae2e-a9c06dc06d8c%40redis&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#AN=354920&db=nlebk</td></tr>
<tr><td></td><td colspan="5">References

Design Thinking by Clarke, Rachel Ivy. Series: Library Futures, Vol. 4. Chicago: ALA Neal-Schuman. 2020. eBook., Database: eBook Collection (EBSCOhost)

https://puniversity.informaticsglobal.com:2282/ehost/detail/detail?vid=4&sid=c80a7d79-eda4-4b7e-a0d6-afafe437962b%40redis&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#AN=2433506&db=nlebk

The Pocket Universal Methods of Design: 100 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions by Bruce Hanington; Bella Martin. Minneapolis: Rockport Publishers. 2017. eBook., Database: eBook Collection (EBSCOhost)

https://puniversity.informaticsglobal.com:2282/ehost/detail/detail?vid=11&sid=f086b8c2-260e-4caa-8c48-d732c21a7724%40redis&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#AN=1638693&db=nlebk

What Is Design Thinking and Why Is It Important? By Rim Razzouk and Valerie Shute - Review of Educational Research, Vol. 82, No. 3 (September 2012), pp. 330-348 (19 pages), Published by: American Educational Research Association

https://puniversity.informaticsglobal.com:2054/stable/23260048?Search=yes&resultItemClick=true&searchText=design+thinking&searchUri=%2Faction%2FdoBasicSearch%3FQuery%3Ddesign%2Bthi</td></tr>
</table>

	nking%26so%3Drel&ab_segments=0%2FSYC-6168%2Ftest&refreqid=fastly-default%3Acb1be24976e25734cb5fc13a8af6fdfb&seq=1#metadata_info_tab_contents Abductive Thinking and Sensemaking: The Drivers of Design Synthesis by John Kolko, Design Issues, Vol. 26, No. 1 (Winter, 2010), pp. 15-28 (14 pages), Published by: The MIT Press https://puniversity.informaticsglobal.com:2054/stable/20627839?Search=yes&resultItemClick=true&searchText=design+thinking&searchUri=%2Faction%2FdoBasicSearch%3FQuery%3Ddesign%2Bthinking%26so%3Drel&ab_segments=0%2FSYC-6168%2Ftest&refreqid=fastly-default%3A0b89336ea274d63c010536b01316d7bb&seq=1#metadata_info_tab_contents Designerly Ways of Knowing: Design Discipline versus Design Science by Nigel Cross, Design Issues, Vol. 17, No. 3 (Summer, 2001), pp. 49-55 (7 pages), Published by: The MIT Press https://puniversity.informaticsglobal.com:2054/stable/1511801?Search=yes&resultItemClick=true&searchText=design+thinking&searchUri=%2Faction%2FdoBasicSearch%3FQuery%3Ddesign%2Bthinking%26so%3Drel&ab_segments=0%2FSYC-6168%2Ftest&refreqid=fastly-default%3A0d5b607b163f60876ca973ed90e22b1c&seq=1#metadata_info_tab_contents

Course Code: PHY2504	Course Title: Optoelectronics and Quantum Physics Lab Type of Course: 1] School Core	L-T-P-C	0	0	2	1
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	The laboratory provides an opportunity to validate the concepts taught and enhances the ability to use the concepts for technological applications. The laboratory tasks aim to develop following skills: An attitude of enquiry, confidence and ability to tackle new problems, ability to interpret events and results, observe and measure physical phenomena, select suitable equipment, instrument and materials, locate faults in systems.					
Course Out Comes	On successful completion of the course the students shall be able to: CO1: To understand electrical and optical properties of materials CO2: Interpret the results of various experiments to verify the concepts used in optoelectronics and advanced devices.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of " Applied Physics for Computer Science Cluster "and attain Skill Development through Experiential Learning techniques					
List of Laboratory Tasks: Experiment No. 1: Experimental errors and uncertainty using excel						

Level 1: Calculation of accuracy and precision of a given data

Level 2: propagation of errors in addition, subtraction, multiplication and division.

Experiment N0 2: To determine the wavelength of semiconductor diode Laser and to estimate the particle size of lycopodium powder using diffraction.

Level 1: Determination of Wavelength of Laser

Level 2: Finding the particle size of lycopodium powder.

Experiment No. 3: To determine the proportionality of Hall Voltage, magnetic flux density and the polarity of Charge carrier.

Level 1: To determine the proportionality of Hall Voltage and magnetic flux density

Level 2: To determine the polarity of Charge carrier.

Experiment No. 4: To study the I-V characteristics of a given zener diode in forward and reverse bias conditions.

Level 1: To study I –V characteristics of the given Zener diode in reverse bias and to determine break down voltage.

Level 2: To study I –V characteristics of the given Zener diode in forward bias and to determine knee voltage and forward resistance.

Experiment No. 5: To study input and output characteristics of a given Transistor.

Level 1: To determine the input resistance of a given transistor.

Level 2: To determine current transfer characteristics and transistor parameters of a given transistor.

Experiment No. 6: Determination of Fermi energy and Fermi temperature of a given metal and bimetallic wire.

Level 1: Determination of Fermi energy and Fermi temperature of given metal wire.

Level 2: Determination of Fermi energy and Fermi temperature of given bimetallic wire.

Experiment No. 7: To study the I-V characteristics and I-R characteristics of a solar cell as a function of the irradiance.

Level 1: To study the I-V characteristics

Level 2:   I-R characteristics of a solar cell as a function of the irradiance.

Experiment No. 8:   Calculate the numerical aperture and study the losses that occur in optical fiber cable. .

Level 1:   Calculate the numerical aperture.

Level 2:   study the losses that occur in optical fiber cable.

Experiment No. 9:   Plotting I-V characteristics in forward and reverse bias for LEDs

and Determination of knee voltage.

Level 1:   Plotting I-V characteristics in forward and reverse bias for LEDs

Level 2: Determination of knee voltage.

Experiment No. 10: Determination of Stefan's constant and verification of Stefan-Boltzmann Law.

Level 1:   Determination of Stefan's constant

Level 2:   Verification of Stefan-Boltzmann Law.

Experiment No. 11: : Dielectric constant

Level 1: Determination of Dielectric constant of given material

Level 2: compare the obtain results with other materials

Experiment No. 12: determine the wavelength of monochromatic light, such as sodium light, using Newton's rings.

Level 1:   Determination of wavelength

Level 2: determine the radius of curvature of the Plano-convex lens.

Targeted Application & Tools that can be used:

Areas of application are optoelectronics industry, Solar panel technologies, quantum computing software, electronic devices using transistors and diodes, memory devices, endoscopy, SQUIDS in MRI, Advanced material characterizations using SEM and STM.

Origin, excel and Mat lab soft wares for programming and data analysis.
Project work/Assignment: Mention the Type of Project /Assignment proposed for this course
Assessment Type Midterm exam Assignment (review of digital/ e-resource from PU link given in references section - mandatory to submit screen shot accessing digital resource.) Quiz End Term Exam Self-Learning 1. Prepare a comprehensive report on non-conventional energy resources in Karnataka and their pros and cons. 2. Write a report on importance of quantum entanglement in supercomputers.

Course Code: PPS1025	Course Title: Industry Readiness Program – I Type of Course: Practical Only Course	L- T - P- C	0	0	2	0
Version No.	1.0					
Course Pre-requisites	Students are expected to understand Basic English. Students should have desire and enthusiasm to involve, participate and learn.					
Anti-requisites	NIL					

Course Description	This course is designed to enable students to set SMART goals, form professional & personal ethics for success and learn various email writing techniques. The course will benefit learners in presenting themselves effectively through various activities and learning methodologies.
Course Objective	The objective of the course is to familiarize the learners with the concepts of "Employability for Young Professionals" and attain SKILL DEVELOPMENT through PARTICIPATIVE LEARNING techniques.
Course Out Comes	On successful completion of this course the students shall be able to: CO 1 Define their career goals CO 2 Practice ethical habits for better career success CO3 Demonstrate effective email writing techniques
Course Content	

Module 1	Goal Setting & Grooming	Classroom activities	10 Hours
Topics: SMART Goals, formal grooming through self-introduction activity Activity: Real world scenarios			
Module 2	Habit Formation	Role plays	10 Hours
Topics: Professional and Personal ethics for success and activity-based practice Activity: Students to present 2 min video on building professional ethics			

Module 3	Email Etiquettes	Individual and group presentation	10 Hours
Topics: Types of prompts to generate effective or desired results for email etiquettes Activity: Individual student presenting various search prompts			
Faculty: L&D			
Targeted Application & Tools that can be used: TED Talks You Tube Links Activities			
Assignment proposed for this course Assignment 1: SMART Goal Assignment 2: AI tools for prompt search			
Continuous Individual Assessment Module 1: Presentation Module 2: Activity based assessment Module 3: Class assessment			

The topics related to skill development: Students acquire knowledge on SMART goals, implement grooming standards, practice ethical behavior in class and campus, acquire hands-on experience to use AI tools to get search prompts for desired email etiquettes.

<table>
<tr><td>Course Code:
ECE2052</td><td>Course Title: Digital Design Lab
Type of Course: Theory &Integrated Laboratory</td><td>L- T-P- C</td><td>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>Version No.</td><td colspan="6">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="6">NIL</td></tr>
<tr><td>Anti-requisites</td><td colspan="6">NIL</td></tr>
<tr><td>Course Description</td><td colspan="6">The purpose of this course is to enable the students to appreciate the fundamentals of digital logic circuits and Boolean algebra focusing on both combinational and sequential logic circuits. The course emphasizes on minimization techniques for making canonical and low-cost digital circuit implementations. This course deals with analysis and design of digital electronic circuits. The course also creates a foundation for future courses which includes Computer Architecture, Microprocessors, Microcontrollers, and Embedded Systems etc. The course enhances the Design, Implementation and Programming abilities through laboratory tasks. The associated laboratory provides an opportunity to verify the theoretical knowledge.</td></tr>
<tr><td>Course Objective</td><td colspan="6">The objective of the course is to familiarize the learners with the concepts of Digital Design and attain the SKILL DEVELOPMENT through EXPERIENTIAL LEARNING.</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">On successful completion of this course the students shall be able to:
Implement various universal gates and Boolean functions circuits using logic gates.
Implement various combinational and sequential logic circuits using logic gates.</td></tr>
<tr><td>Course Content:</td><td colspan="6"></td></tr>
<tr><td colspan="7">List of Laboratory Tasks:
Experiment N0 1: Verify the Logic Gates truth table
Level 1: By using Digital Logic Trainer kit
Level 2: By using Analog devices like RPS, Volt meter, Resistors and ICs

Experiment No. 2: Verify the Boolean Function and Rules
Level 1: By using Digital Logic Trainer kit
Level 2: By using Analog devices like RPS, Volt meter, Resistors and ICs</td></tr>
</table>

Experiment No. 3: Design and Implementations of HA/FA

Level 1: By using basic logic gates and Trainer Kit

Level 2: By using Universal logic gates and Trainer Kit

Experiment No. 4: Design and Implementations of HS/FS

Level 1: By using basic logic gates and Trainer Kit

Level 2: By using Universal logic gates and Trainer Kit

Experiment No. 5: Design and Implementations of combinational logic circuit for specifications

Level 1: Specifications given in the form of Truth table

Level 2: Specification should be extracted from the given scenario

Experiment No. 6: Study of Flip flops

Experiment No. 7: Design and Implementations of sequential logic circuit for specifications

Level 1: Specifications given in the form of Truth table

Level 2: Specification should be extracted from the given scenario

Experiment No.8: HDL coding for basic combinational logic circuits

Level 1: Gate level Modeling

Level 2: Behavioral Modeling

Experiment No.9: HDL coding for basic sequential logic circuit

Level 1: Gate level Modeling

Level 2: Behavioral Modeling

Targeted Application & Tools that can be used:

Digital electronics is the foundation of all modern electronic devices such as cellular phones, MP3 players, laptop computers, digital cameras, high definition televisions, Home Automation, Communication in systems in industries

Professionally Used Software: HDL/VHDL/Verilog HDL/ OOPS
Text Book(s): Mano, M. Morris and Ciletti Michael D., “Digital Design”, Pearson Education, 6th edition Thomas L. Floyd “DIGITAL LOGIC DESIGN” , Pearson Education, fourth edition.
Reference(s): Reference Book(s): R1. Jain, R. P., “Modern Digital Electronics”, McGraw Hill Education (India), 4th Edition R2. Roth, Charles H., Jr and Kinney Larry L., “Fundamentals of logic Design”, Cengage Learning, 7th Edition Online Resources (e-books, notes, ppts, video lectures etc.): Book Free Download (studymaterialz.in) eBook1: Mano, M. Morris and Ciletti Michael D., “Digital Design”, Pearson Education. {[PDF] Digital Design By M. Morris Mano, Michael D Ciletti Book Free Download } eBook2:Floyd “DIGITAL LOGIC DESIGN” fourth edition- ePub, eBook- [PDF] DIGITAL LOGIC DESIGN FOURTH EDITION FLOYD | abri.engenderhealth.org. NPTEL Course- NPTEL :: Electrical Engineering - NOC:Digital Electronic Circuits Digital Logic Design PPT Slide 1 (iare.ac.in) Lab Tutorial: Multisim Tutorial for Digital Circuits - Bing video CircuitVerse - Digital Circuit Simulator online Learn Logisim➠ Beginners Tutorial | Easy Explanation! - Bing video Digital Design 5: LOGISIM Tutorial & Demo 7. https://presiuniv.knimbus.com/user#/home E-content:

Z. Xin-Li and W. Hong-Ying, "The Application of Digital Electronics in Networking Communication," 2016 Eighth International Conference on Measuring Technology and Mechatronics Automation (ICMTMA), 2016, pp. 684-687, doi: 10.1109/ICMTMA.2016.168.

An encoding technique for design and optimization of combinational logic circuit DipayanBhadra;Tanvir Ahmed Tarique;Sultan Uddin Ahmed;Md. Shahjahan;KazuyukiMurase2010 13th International Conference on Computer and Information Technology (ICCIT)

A. Matrosova and V. Provkin, "Applying Incompletely Specified Boolean Functions for Patch Circuit Generation," 2021 IEEE East-West Design & Test Symposium (EWDTS), 2021, pp. 1-4, doi: 10.1109/EWDTS52692.2021.9581029.

A. Matrosova, V. Provkin and E. Nikolaeva, "Masking Internal Node Faults and Trojan Circuits in Logical Circuits," 2019 IEEE East-West Design & Test Symposium (EWDTS), 2019, pp. 1-4, doi: 10.1109/EWDTS.2019.8884434.

Topics relevant to “SKILL DEVELOPMENT”: Adders, Multiplexers, Decoders / Encoders; Flip-Flops, Counters and Registers for Skill Development through Experiential Learning techniques. This is attained through assessment component mentioned in course handout.

Course Code: MAT2402	Course Title: Probability and Statistics Type of Course:1] School Core		L-T- P- C	3	1	0	4
Version No.		1.0					
Course Pre-requisites		MAT2301					
Anti-requisites		NIL					
Course Description		The course introduces the concepts of probability theory and statistical analysis, covering how to collect, organize, interpret, and draw inferences from data using mathematical models to understand randomness and uncertainty, with applications across various fields like science, engineering, economics, and social sciences.					

Course Objective		The objective of the course is to equip students with the foundational knowledge of probability theory and statistical methods, enabling them to collect, analyze, interpret data, and make informed decisions based on the likelihood of events occurring in various situations, often applied across different fields like science, engineering, and business.		
Course Out Comes		On successful completion of the course the students shall be able to: CO1 - be able to compute conditional probabilities directly and using Bayes' theorem, and check for independence of events. CO2 - be able to set up and work with discrete & continuous random variables; in particular, to understand the Bernoulli, binomial, geometric, Poisson distributions, uniform, normal, and exponential distributions. CO3 - Identifying different types of data relationships (linear, polynomial, exponential, logarithmic). CO4 - be able to use specific significance tests, including z-test, t-test (one- and two-sample), and chi-squared test		
Course Content:				
Module 1	Basic Probability			(15 Classes)
Probability of an Event, multiplication rule, combinations, permutations, Addition Law, Multiplication Law, Conditional Probability, Bayes's Theorem and Problems.				
Module 2	Random Variables and Bivariate Distributions		Assignment	(15 Classes)
Random Variables (discrete and continuous), Probability Mass/Density Functions, Mathematical Expectations, discrete probability distributions - Binomial distribution, Poisson distribution, geometric distribution, Continuous uniform distribution - exponential distribution, normal distribution, gamma distribution. Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule.				
Module 3	Curve Fitting & Statistical Methods			(15 Classes)
Curve Fitting (Straight Line (y = a + bx), Parabola (y = a + bx + cx2), Exponential Curves (y = aebx, y = abx and y = axb) Measures of Central tendency, Moments, skewness and Kurtosis, Correlation - Karl Pearson's coefficient of correlation and rank correlation (with & Without repetition, Multiple Correlation - Problems. Regression analysis - lines of regression, Multiple regression - Problems.				
Module 4	Joint Probability Distribution and Sampling Theory		Assignment	(15 Classes)
Joint Probability distribution for two discrete random variables, expectation and covariance.				

Random sampling, sampling distributions, Standard Error, Type I & Type II errors, Testing of Hypothesis, Test of significance - Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations, Test for single mean, difference of means and correlation coefficients, test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.
Targeted Application & Tools that can be used: The contents of this course has direct applications in most of the core engineering courses for problem formulations, Problem Solution and system Design. Tools Used: R software (Open Source)
Assignment:
Select any one simple differential equation pertaining to the respective branch of engineering, identify the dependent and independent variable – Obtain the solution and compare the solution sets by varying the values of the dependent variable.
Text Book Ronald .E. Walpole, Raymond. H. Myers, Sharon. L Myers, and Keying E. Ye, “Probability and Statistics for Engineers and Scientists”, Pearson Education, Delhi-9th edition, 2012. B. S. Grewal (2017), Higher Engineering Mathematics by, 44th Edition, Khanna Publishers.
References: Miller and Freund, Probability and Statistics for Engineers, Pearson Education Ltd. Erwin Kreyzig, Advanced Engineering Mathematics, John Wiley and sons, Inc.10th Edition. Douglas C. Montgomery & George Runger, Applied Statistics and Probability for Engineers, , Wiley Publications   E-resources/ Web links: https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_10427 https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_100198 https://nptel.ac.in/courses/109104124 https://nptel.ac.in/courses/111106051 https://nptel.ac.in/courses/111102137 https://www.math.hkust.edu.hk/~maqian/ma006_0607F.html https://www.scu.edu.au/study-at-scu/units/math1005/2022/ Presidency University's Knimbus library URL is: presiuniv.knimbus.com

Topics relevant to SKILL DEVELOPMENT: The course focuses on the concepts of Vector calculus and Linear Algebra with reference to specific engineering problems. The course is of both conceptual and analytical type in nature through Problem Solving. This is attained through the assessment component mentioned in the course handout.

<table>
<tr><td>Course Code: CHE7601</td><td colspan="2">Course Title: Environmental Science

Type of Course: MAC- Theory</td><td>L- T- P- C</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Version No.</td><td colspan="7">2.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="7">NIL</td></tr>
<tr><td>Anti-
Requisites</td><td colspan="7">NIL</td></tr>
<tr><td>Course Description</td><td colspan="7">This course emphasizes the need to conserve biodiversity and adopt a more sustainable lifestyle by utilizing resources in a responsible way. Topics covered include basic principles of ecosystem functions; biodiversity and its conservation; human population growth; water resources, pollution; climate change; energy resources, and sustainability; Sustaining human societies, policies, and education.

This course is designed to cater to Environment and Sustainability</td></tr>
<tr><td>Course Objective</td><td colspan="7">The objective of the course is to familiarize the learners with the concepts of “Environmental Science” and attain SKILL DEVELOPMENT through EXPERIENTIAL LEARNING techniques.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On successful completion of this course the students shall be able to:

Appreciate the historical context of human interactions with the environment and the need for eco-balance.

Describe basic knowledge about global climate change with particular reference to the Indian context.

Understand biodiversity and its conservation

Develop an understanding on types of pollution and ways to protect the environment

Learn about various strategies on Global environmental management systems</td></tr>
<tr><td>Course Content:</td><td colspan="7"></td></tr>
<tr><td>Module 1</td><td>Humans and the Environment</td><td>Assignment</td><td>Data
Collection</td><td colspan="4">01 class</td></tr>
</table>

Topics: The man-environment interaction: Mastery of fire; Origin of agriculture; Emergence of city-states; Great ancient civilizations and the environment. Self-learning topics: Humans as hunter-gatherers; Industrial revolution and its impact on the environment; Environmental Ethics and emergence of environmentalism.				
Module 2	Natural Resources and Sustainable Development	Assignment		03 Classes

Topics: Overview of natural resources: Definition of resource; Classification of natural resources- biotic and abiotic, renewable and non-renewable. Water resources: Types of water resources- fresh water and marine resources; Soil and mineral resources: Important minerals; Mineral exploitation Soil as a resource and its degradation. Energy resources: Sources of energy and their classification, renewable and non-renewable sources of energy; Advantages and disadvantages. Self- learning topics: Availability and use of water resources; Environmental impact of over-exploitation, issues and challenges.; Environmental problems due to extraction of minerals and use; Sustainable Development Goals (SDGs)- targets, indicators, and challenges for SDGs.				
Module 3	Environmental Issues: Local, Regional and Global	Case study		02 Classes
Topics: Environmental Pollution: Types of Pollution- air, noise, water, soil, municipal solid waste, hazardous waste; Trans- boundary air pollution; Acid rain; Smog. Land use and Land cover change: land degradation, deforestation, desertification, urbanization. Global change: Ozone layer depletion; Climate change Self -learning topics: Environmental issues and scales				

	Module 4	Conservation of Biodiversity and Ecosystems	Assignment		02 Classes
Topics: Biodiversity-Introduction, types, Species interactions, Extinct, endemic, endangered and rare species, Threats to biodiversity: Natural and anthropogenic activities. Self-learning topics: Mega-biodiversity, Hot-spots, Major conservation policies. Biodiversity loss: past and current trends, impact.					

	Module 5	Environmental Pollution and Health	Case study		03 Classes

Topics:

Pollution, Definition, point and nonpoint sources of pollution, Air pollution- sources, major air pollutants, health impacts of air pollution.

Water pollution– Pollution sources, adverse health impacts on human and aquatic life and mitigation, Water quality parameters and standards.

Soil pollution and solid waste- Soil pollutants and their sources, solid and hazardous waste, Impact on human health.

Self-learning topics: Noise pollution, Thermal and radioactive pollution.

	Module 6	Climate Change: Impacts, Adaptation and Mitigation	Assignment/case		02 Classes

Topics:

Understanding climate change: Natural variations in climate; Projections of global climate change with special reference to temperature, rainfall and extreme events; Importance of 1.5 °C and 2.0 °C limits to global warming; Impacts

Vulnerability and adaptation to climate change: Observed impacts of climate change on ocean and land systems; Sea level rise, changes in marine and coastal ecosystems; Impacts on forests and natural ecosystems; Indigenous knowledge for adaptation to climate change.

Self-learning topics: Mitigation of climate change: Synergies between adaptation and mitigation measures; National and international policy instruments for mitigation.

	Module 7	Environmental Management	Case study	Data analysis	02 Classes

Topics:

Environmental management system: ISO 14001; Environmental risk assessment Pollution control and management; Waste Management- Concept of 3R (Reduce, Recycle and Reuse) and sustainability.

Self-learning topics: Environmental audit and impact assessment; Eco labeling /Eco mark scheme

	Module 8	Environmental Treaties and	Case study	Data analysis	01 Classes

		Legislation			

Topics: Major International Environmental Agreements: Convention on Biological Diversity (CBD), Major Indian Environmental Legislations: Environmental Protection Act, Forest Conservation Act, Public awareness. Self-learning topics: Paris Agreement, Conference of the Parties (COP), India's status as a party to major conventions: Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act.
Targeted Application & Tools that can be used: Application areas are Energy, Environment and sustainability Tools: Statistical analysis of environmental pollutants using excel, origin etc.
Project work/Assignment:
Assessment Type Midterm exam Assignment (review of digital/ e-resource from PU link given in references section - mandatory to submit screenshot accessing the digital resource.) Lab evaluation/Assignment End Term Exam Self-learning Assignment 1: Write a Statement of Environment report of your town/city/state/country

Assignment 2: Individual students will carry out the analyses of polluted solid, liquid, and gaseous samples and propose suitable mitigation measures. A detailed and in-depth report needs to be submitted for each case. This may include preparation of reagents, sample preparation (extraction), chemical analysis carried out, instruments and tools used, data collected and processed, inferences made and conclusions arrived at. Necessary support is given in the form of lab manual and reference links to e-books.
Text Book G. Tyler Miller and Scott Spoolman (2020), Living in the Environment, 20th Edition, Cengage Learning, USA Krishnamurthy, K.V. (2003) Text book of Biodiversity, Science Publishers, Plymouth, UK.

Jackson, A.R. & Jackson, J.M. (2000), Environmental Science: The natural environment and human impact, Pearson Education.

Reference Books

Fisher, Michael H. (2018) An Environmental History of India- From Earliest Times to the Twenty-First Century, Cambridge University Press.

William P. Cunningham and Mary Ann Cunningham (2017), Principles of Environmental Science: Inquiry & Applications, 8th Edition, McGraw-Hill Education, USA.

Sinha N., (2020) Wild and Wilful. Harper Collins, India.

www.ipcc.org; https://www.ipcc.ch/report/sixth-assessment-report-cycle/

Theodore, M. K. and Theodore, Louis (2021) Introduction to Environmental Management, 2nd Edition. CRC Press.

Richard A. Marcantonio, Marc Lame (2022). Environmental Management: Concepts and Practical Skills. Cambridge University Press.

E-resources:

https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=DO AB_1_06082022_18126

https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=DO AB_1_06082022_8761

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https://presiuniv.knimbus.com/user#/searchresult?searchId=3R%20principle&_t=1687427221129

https://presiuniv.knimbus.com/user#/searchresult?searchId=eco%20labelling&_t=1687427279979

https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=TEXTBOOK_LIBRARY01_06082022_395&xIndex=4

https://www.ugc.gov.in/oldpdf/modelcurriculum/env.pdf

Course Code: CIV1200	Course Title: Foundations of Integrated Engineering Type of Course: Theory Only	L- T-P-C	2	0	0	2
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	This interdisciplinary course introduces first-year engineering students to foundational principles and practices across key engineering domains, emphasizing real-world problem-solving, sustainability, and ethical innovation. Students explore how civil, mechanical, electrical, and IT systems intersect with emerging technologies like IoT, AI, and geomatics to address global challenges. Through case studies, learners gain deeper understanding of smart infrastructure, prototyping mechanical/electronic systems, and securing IT solutions. Topics include bioinformatics for environmental monitoring, GIS-enabled urban planning, renewable energy integration, and cybersecurity fundamentals. The course cultivates a holistic understanding of engineering's role in sustainable development, safety, and ethical decision-making, preparing students to contribute meaningfully to multidisciplinary projects in a technology-driven world.					
Course Objective	The objective of the course is skill development of student by using Participative Learning techniques.					
Course Outcomes	On successful completion of this course the students shall be able to: 1] Recall key principles of Agile, DevOps, and bioinformatics used in interdisciplinary engineering contexts. 2] Explain the role of GIS, LiDAR, and sustainable materials in designing smart infrastructure and disaster management systems. 3] Describe core components of mechanical systems and their real-world applications. 4] Describe the functionality of IoT-enabled wearable devices, embedded systems, and renewable energy integration in smart grids. 5] List foundational IT concepts such as cloud computing architectures, cybersecurity threats, and blockchain applications.					
Course Content:						

Module 1	Foundations of Engineering Practice	Assignment	Case studies	6 Sessions
Real-world problem-solving using data logic and practical applications, Collaboration and Innovation through multi-domain project, Engineering Ethics & Environmental Impact Emerging Fields: Automation, and Introduction to bioinformatics and its application Sustainability & Safety: Circular economy principles, carbon footprint analysis.				
Module 2	Civil Engineering & Geomatics	Assignment	Article Review	6 Sessions

Smart Infrastructure & Geomatics: GIS mapping, LiDAR, drone surveys for urban planning, Geospatial data analysis for disaster management. Sustainable Construction: 3D-printed structures, self-healing concrete, Digital twins for infrastructure monitoring. Green Innovations: Net-zero energy buildings, rainwater harvesting systems.				
Module 3	Mechanical Engineering in Action	Assignment & Quiz	Data Collection	6 Sessions
Advanced Manufacturing: Collaborative robots (cobots), additive manufacturing and 3D printing, Reverse engineering and prototyping. Energy Systems: Solar/wind energy harvesting, piezoelectric applications. Biomechanics: Prosthetics design, ergonomic product lifecycle.				
Module 4	Electrical & Electronics Engineering	Assignment & Quiz	Data Collection and visualization	6 Sessions
Smart Devices & Systems: Embedded systems, Wearable technology, Edge computing and hardware platforms Energy Innovations: EV charging infrastructure, wireless power transfer, Smart grid integration with renewables.				
Module 5	Fundamentals of IT	Assignment & Quiz	Case studies	6 Sessions
Core IT Topics: Networking basics, Cloud computing Cybersecurity & Data: Encryption, phishing prevention, zero-trust models, Database management. Emerging Tech: Blockchain for supply chains, AI/ML basics, IoT integration with cloud platforms				
Targeted Application & Tools that can be used: Application Areas include Interdisciplinary problem-solving, Smart city planning, disaster management, Robotics prototyping, renewable energy systems, Wearable health tech, smart grids, Secure cloud systems. Tools: 3D Printers, Autocad, Tinkercad, ArcGIS / QGIS, Arduino/Raspberry Pi				
Text Book: William Oakes & Les Leone, "Engineering Your Future: An Introduction to Engineering", Oxford University Press, 9th Edition, 2021 Barry F. Kavanagh, “Introduction to Geomatics”, Pearson, 5th Edition, 2021 Ian Gibson, David Rosen, & Brent Stucker, “Additive Manufacturing Technologies”, Springer, 3rd Edition, 2021 Sudip Misra, "The Internet of Things: Enabling Technologies, Protocols, and Use Cases", Wiley, 2nd Edition, 2022 James Kurose & Keith Ross, “Computer Networking: A Top-Down Approach”, Pearson, 8th Edition, 2020				

References

Supratim Choudhuri, “Bioinformatics for Beginners: Genes, Genomes, and Molecular Evolution", Academic Press, 1st Edition, 2023,

Robert McGinn, "The Ethical Engineer: Contemporary Concepts and Cases", Princeton University Press, 1st Edition, 2020

Charles J. Kibert, “Sustainable Construction: Green Building Design and Delivery”, Wiley, 5th Edition, 2022

Anthony M. Townsend, "Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia", W.W. Norton & Company, 1st Edition, 2020

David Buchla, "Renewable Energy Systems: A Smart Energy Systems Approach", Pearson, 2nd Edition, 2023

Charles Platt, "Make: Electronics: Learning Through Discovery", Make Community, 3rd Edition, 2021

Charles J. Brooks, Christopher Grow, & Philip Craig, “Cybersecurity Essentials", Wiley, 2nd Edition, 2021

Web-resources:

Post-parametric Automation in Design and Construction

https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=1155197&site=ehost-live

Smart Cities : Introducing Digital Innovation to Cities

https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=1993146&site=ehost-live

Innovation Energy: Trends and Perspectives or Challenges of Energy Innovation

https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=2323766&site=ehost-live

Additive Manufacturing: Opportunities, Challenges, Implications

https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=1134464&site=ehost-live

Course Code: CHE2501	Course Title: Chemistry of Smart Materials Type of Course: Theory - BSC	L-T- P- C	3	0	0	3
Version No.	1.0					
Course Pre-requisites						
Anti-requisites	NIL					

<table>
<tr><td>Course Description</td><td colspan="4">The objective of the course is to introduce the students to concepts and applications of chemistry of smart materials. The course also aims to enhance the knowledge of smart materials associated with memory system, display devices, , sensors, energy devices and environment. It will also cultivate an ability to identify chemistry in each of smart engineered materials and interpret solutions for the challenges connected to memory, display, energy, smart, green and sustainable technologies. It targets to strengthen the fundamental concepts behind chemistry of smart materials and then builds an interface with their industrial applications.

This course is designed to cater to Environment and Sustainability</td></tr>
<tr><td>Course

Objective</td><td colspan="4">The objective of the course is ‘SKILL DEVELOPMENT’ of the student by using Participative learning techniques.</td></tr>
<tr><td>Course Outcomes</td><td colspan="4">On successful completion of this course the students shall be able to:

Relate the knowledge of chemistry to computational approaches to identify materials functionalities and properties

Recognize and interpret solutions for the challenges connected to memory, display, smart, green and sustainable technologies.

Explain the quality parameters of engineering materials associated with environment and sensors.

Interpret the knowledge of sustainable chemistry for E- waste management.

Analyse the importance of various electrochemical sources in energy systems.</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>Computational Chemistry</td><td>Assignment</td><td>Data Collection and analysis</td><td>09 classes</td></tr>
<tr><td colspan="5">Topics: Fundamental particles of atom – their mass, charge and location – atomic number and mass number, Stabilizing interactions: Bonded and non-bonded interactions. Chemistry of weak interactions – van der Waals force and hydrogen bonding, Density functional theory. 3D co-ordinate generation for small molecules, geometry optimization by Molview. Chemical Databases: Chemoinformatics, MSDS

Self- learning topics: Scope, cost and efficiency of computational modeling.</td></tr>
<tr><td>Module 2</td><td>Materials for Memory and Display Systems</td><td>Assignment</td><td>Data Collection and analysis</td><td>09
Classes</td></tr>
<tr><td colspan="5">Topics: Memory Systems : Introduction, classification of electronic memory devices- Transistor, capacitor, charge -transfer and Resistor, types of materials - organic, polymeric and hybrid materials, and applications, manufacturing of semiconductor chips.

Display Systems: photo and electroactive materials , materials for display -Principle, Properties and applications: Liquid crystals for LCD-Liquid crystals display, Basics of LED: OLED-organic light emitting diode and light emitting electrochemical cells.

Self- learning topics: Green computing: Biocomposite based memory devices</td></tr>
</table>

Module 3	Nanomaterials based Smart Sensors and Devices	Assignment	Data Collection and analysis	09 Classes

Topics: Nanomaterials- Introduction, classification based on dimensionality, quantum confinement. Size dependent properties, Synthesis, Properties of CNT and Graphene and their application as Materials for data analysis and packaging -RFID and IONT.

Sensors: Introduction, types, Principle and applications- electrochemical sensor: nanomaterials for sensing applications - Glucose, VOC sensing.

Self-learning topics: Fullerene, biomolecules in sensing, Strain sensors

Module 4	Sustainable Materials and Development	Quiz/Seminar	Data Collection and analysis	09 Classes

Topics: E waste: Introduction, E waste Hazards, E- waste management, Recovery of precious metal- Cu by Hydrometallurgy.

Green Chemistry: Fundamentals and 12 principles with examples, Carbon footprint and sequestration

Sustainable Chemistry: -Introduction to Biomaterials- PLA , polymers in bio-compatible and bio-degradable materials - Poly(3-hydroxybutyrate-co-3-hydroxyvalerate) PHBV, synthesis and applications in drug delivery.

Self-learning topics: circular economy- case studies.

Module 5	Energy Science	Quiz/Seminar	Data Collection and analysis	09 Classes

Topics: Battery technology:Fundamentals of electrochemistry, Introduction to electrochemical storage devices: battery (Lithium-ion battery- $LiMnO_2$, $LiCoO_2$, metal air batteries- LiO_2) and supercapacitors-Introduction, Principle, Types - EDLC, pseudo and asymmetric capacitor.

Photovoltaics: Solar cells - Construction and working principle; types- Inorganic, Organic and quantum dot sensitized (QDSSC's).

Self -learning topics: Battery technology for e-mobility, Green hydrogen

Targeted Application & Tools that can be used:

Application areas are Data storage and analysis, logistics, Biomedicine, Energy, Environment and sustainability

Tools: Molview, chemdraw, excel etc

Project work/Assignment:

Assessment Type

Midterm exam

Assignment (review of digital/ e-resource from PU link given in references section - mandatory to submit screenshot accessing the digital resource.)

Quiz/Student Seminar

End Term Exam

Self-learning

Text Book

Wiley, "Engineering Chemistry", Wiley.

G.A. Ozin and A.C. Arsenault, Nanochemistry: A chemical approach to nanomaterials, Royal Society of Chemistry, 2009

Reference Books

Functional and smart materials, Chander Prakash, Sunpreet Singh, J. Paulo Davim, 2020, CRC Press,

ISBN: 978-036-727-510-5.

E-waste recycling and management: present scenarios and environmental issues, Khan, Anish, and

Abdullah M. Asiri. 2019, Springer, Vol. 33. ISBN: 978-3-030-14186-8.

Essentials of computational chemistry: theories and models, Christopher J Cramer, 2013, John Wiley &

Sons. ISBN: 978-0-470-09182-1.

Energy storage and conversion devices: Supercapacitors, batteries and hydroelectric cells, Anurag Gaur,

L. Sharma, Anil Arya. 2021, CRC press, 1st edition, ISBN: 978-1-003-14176-1.

Fundamentals of analytical chemistry: An introduction, Douglas A. Skooget etal., 2004 Thomson Asia pte

Ltd., 8th, ISBN: 978-0-495-55828-6

Functional and smart materials, Chander Prakash, Sunpreet Singh, J. Paulo Davim, 2020, CRC Press,

ISBN: 978-036-727-510-5.

Electrical and electronic devices, circuits and materials: Technological challenges and solutions. Tripathi,

L., Alvi, P. A., & Subramaniam, U, 2021, John Wiley & Sons, ISBN: 978-0367564261.

F. Jensen, Introduction to Computational Chemistry, 3rd edition, Wiley, 2017.

E resources

https://presiuniv.knimbus.com/user#/searchresult?searchId=computational%20chemistry&_t=1738054970142

https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_48504

https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_147967

https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_130301

https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_87297

https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_67006

https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_137261

https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_86712
Skill Sets All topics in theory component are relevant to Environment and Sustainability.

Course Code: CSE2200	Course Title: Program Solving Using C Type of Course: Theory		L- T-P-C	2	0	0	2
Version No.	1.0						
Course Pre-requisites	NIL						
Anti-requisites	NIL						
Course Description	The course is designed to provide complete knowledge of C language. Students will be able to develop logics which will help them to create programs and applications in C. Also by learning the basic programming constructs they can easily switch over to any other language in future.						
Course Object	The objective of the course is to familiarize the learners with the concepts of Problem Solving Using C and attain Employability through Problem Solving Methodologies.						
Course Outcomes	On successful completion of this course the students shall be able to: Write algorithms and to draw flowcharts for solving problems Demonstrate knowledge and develop simple applications in C programming constructs Develop and implement applications using arrays and strings Decompose a problem into functions and develop modular reusable code Solve applications in C using structures and Union Design applications using Sequential and Random Access File Processing.						
Course Content:							

Module 1	Introduction to C Language	Quiz	Problem Solving	6 Sessions
Topics: Introduction to Programming – Algorithms – Pseudo Code - Flow Chart – Compilation – Execution – Preprocessor Directives (#define, #include, #undef) - Overview of C – Constants, Variables and Data types – Operators and Expressions – Managing Input and Output Operations – Decision Making and Branching - Decision Making and Looping.				

Module 2	Introduction to Arrays and Strings	Quiz	Problem Solving	6 Sessions
Topics: Arrays: Introduction – One Dimensional Array – Initialization of One Dimensional Arrays – Example Programs – Sorting (Bubble Sort, Selection Sort) – Searching (Linear Search) - Two Dimensional Arrays – Initialization of Two Dimensional Arrays. Example Programs – Matrix operations. Strings: Introduction – Declaring and Initializing String Variables – Reading Strings from Terminal – Writing String to Screen – String Handling Functions.				
Module 3	Functions and Pointers	Quiz	Problem Solving	6 Sessions
Topics: Functions: Introduction – Need for User-defined functions – Elements of User-Defined Functions: declaration, definition and function call–Categories of Functions – Recursion. Pointers: Introduction – Declaring Pointer Variables – Initialization of Variables – Pointer Operators – Pointer Arithmetic – Arrays and Pointers – Parameter Passing: Pass by Value, Pass by Reference.				

Module 4	Structures and Union	Quiz	Problem Solving	6 Sessions
Topics: Structures: Introduction – Defining a Structure – Declaring Structure Variable – Accessing Structure Members – Array of Structures – Arrays within Structures – Union: Introduction – Defining and Declaring Union – Difference Between Union and Structure.				
Module 5	File handling	Case Study	Problem Solving	6 Sessions
Topics: Files: Defining and Opening a File – Closing a File – Input / Output Operations on File – Random Access Files				
Text Book(s): 1. E. Balaguruswamy, "Programming in ANSI C", 8th Edition, 2019, McGraw Hill Education, ISBN: 978-93-5316- 513-0.				
Reference Book(s): Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020. ReemaThareja, "Programming in C", Oxford University Press, Second Edition, 2016. Kernighan, B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2015 Schildt Herbert, "C: The Complete Reference", Tata McGraw Hill Education, 4th Edition, 2014. Stephen G. Kochan, "Programming in C", Addison-Wesley Professional, 4th Edition, 2014.				
Web Links and Video Lectures:				

1.	https://nptel.ac.in/courses/106/105/106105171/
2.	https://archive.nptel.ac.in/courses/106/104/106104128/

Course Code: ENG2501	Course Name: Advanced English Type of Course: HSMC		L- T- P- C	2	0	0	2
Version No.	1.3						
Course Pre-requisites	ENG1900						
Anti-requisites	NIL						
Course Description	The course emphasizes on technical communication at advanced level by exploring critical reading, technical presentation and review writing. The purpose of the course is to enable learners to review literature in any form or any technical article and deliver technical presentations. Extensive activities in practical sessions equip to express themselves in various forms of technical communications. Technical presentations and the module on career setting focus on learners' area of interests and enhance their English language writing skills to communicate effectively.						
Course Out Come	On successful completion of the course the students shall be able to: Develop a critical and informed response reflectively, analytically, discursively, and creatively to their reading. Communicate effectively, creatively, accurately and appropriately in their writing. Deliver technical presentations Design resume and create professional portfolio to find a suitable career						
Course Content: Theory							
Module 1	Critical Reasoning and Writing	Writing Essays	Critical Reading	4 Classes			
Topics: A Catalog of Reading Strategies The Myth of Multitasking A Guide to Writing Essays Speculating about Causes or Effects Is Google Making Us Stupid (Self Study)							
Module 2	Technical Presentation	Presentation	Oral Skills	3 Classes			
Topics: Planning the presentation Creating the presentation							

Giving the presentation				
Module 3	Writing Reviews	Prezi	Review Writing	4 Classes
Topics: Review Writing Short film reviews Advanced English Grammar (Self Study)				
Module 4	Starting your Career	Online Writing Lab	Writing Skills	4 Classes
Topics: Preparing a Resume Writing Effective Application Letter Creating a Professional Portfolio				
Targeted Application & Tools that can be used: Writing reports, Review writing, Group Discussion, Dyadic interviews, Grammarly.com				
Project work/Assignment:				
Academic Journal – Assignment In Academic Journal (CIJ), students compile task and activities completed in each module and submit to the instructor at the middle and end of the semester.				
References Hering, Heik. How to Write Technical Reports: Understanding Structure, Good Design, Convincing Presentation. Springer. Johnson, Richard. (2010) Technical Communication Today. Pearson, 2015 Rice B. Adelrod, Charles R. Cooper and Ellen C. Carillo. (2020) Reading Critically Writing Well: A Reader and Guide. Beford/St. Martin's Macmillan Learning, New York. The Princeton Review. (2010) MCAT Verbal Reasoning & Writing. The Princeton Review, Inc. https://www.hitbullseye.com/Strong-and-Weak-Arguments.php Accessed on 10 Dec 2021 https://www.inc.com/guides/how-to-improve-your-presentation-skills.html Accessed on 10 Dec 2021				
Topics Relevant to "employability": Critical Reasoning, Presentation, Review Writing and Starting Career Topics Relevant to "Human Values and Professional Ethics": Critical reasoning				

Course Code: EEE1200	Course Title: Basics of Electrical and Electronics Engineering.	L-T-P-C	3	0	0	3

	Type of Course: Professional Core - Theory						
Version No.	2.0						
Course Pre-requisites	NIL						
Anti-requisites	NIL						
Course Description	This is a fundamental Course which is designed to know the use of basics of electrical and electronics engineering principles occurs in various fields of Engineering. The course emphasises on the characteristics and applications of electrical and electronic devices. The course also emphasizes on the working, analysis and design of electrical circuits using both active & passive components. Additionally, this course creates a foundation for the future courses such as Electrical machines, power system, power electronics Linear Integrated Circuits, Analog Communication and Digital Communication etc.						
Course Objective	The objective of the course is to familiarize the learners with the concepts of Basics of Electrical and Electronics Engineering and attain Skill Development through Participative Learning techniques.						
Course Outcomes	On successful completion of this course the students shall be able to: Apply basic laws of Electrical Engineering to compute voltage, currents and other parameters in the circuits. Discuss various fundamental parameters appearing in the characteristics of semiconductor devices and their applications. Summarize the operations of different biasing configurations of BJTs and amplifiers. Discuss the performance characteristics and applications of various electrical Machines.						
Course Content:							

Module 1	Introduction to Electrical Circuits	Assignment/ Quiz	Numerical solving Task	10 Sessions

DC Circuits: Concept of Circuit and Network, Types of elements, Network Reduction Techniques- Series and parallel connections of resistive networks, Star–to-Delta Transformations, Mesh Analysis, Nodal Analysis, Numerical examples.

AC Circuits: Fundamentals of single phase circuits - Series RL, RC and R-L-C Circuits, Concept of active power, reactive power and Power factor, Numerical examples.

Introduction to three phase system and relation between line and phase values in Star & Delta connection, Numerical examples.

Module 2	Semiconductor and Diode applications	Assignment/ Quiz	Memory Recall based Quizzes	10 Sessions

Mass Action Law, Charge densities in a semiconductor, Types of SC, Junction diodes -Ideal and practical behaviour, Modelling the Diode Forward Characteristic, and Diode applications like rectifiers, Clipping and clamping circuits. Zener diode, characteristics and its applications like voltage regulator.

Module 3	Transistors and its Applications	Assignment/ Quiz	Memory Recall-based Quizzes	10 Sessions

Transistor characteristics, Current components, BJT Configurations (CB, CC, CE configurations) and their current gains. Operating point, Biasing & stabilization techniques: Fixed Bias, Voltage divider bias and its stability factor and load line analysis. Single and multistage amplifier, Darlington pair.

JFET (Construction, principal of Operation and Volt –Ampere characteristics). Pinch- off voltage, Comparison of BJT and FET. MOSFET (Construction, principal of Operation and symbol), MOSFET characteristics in Enhancement and Depletion modes.

Module 4	Fundamentals of Electrical Machines	Assignment/ Quiz	Numerical solving Task	10 Sessions

Electrical Machines: Single phase transformers: principle of operation and EMF equation, Numerical examples. DC Motor: principle of operation, Back EMF, torque equation, Numerical examples. AC Motor: Principle operation of Induction Motors and its Applications.

Special Machines: Introduction to special electrical machines and its applications.

Targeted Application & Tools that can be used:

Targeted Applications: Application Area includes all electrical and electronic circuits (power supply unit, regulator unit, embedded devices, hardware electronics etc.). The students will be able to join a profession which involves basics to high level of electronic circuit design.

Professionally Used Software: Multisim/ P Spice

Besides these software tools hardware equipment such as Multimeters, Function Generators, Power Supplies, Oscilloscopes etc., can be used to perform component/circuit testing and analysis..

Project Work/ Assignment:

1. Article review: At the end, of course an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format.

2. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

3. Case Study: - At the end of the course students will be given a 'real-world' application based circuits like Power Amplifier, Signal/Function Generator etc. as a case study. Students will be submitting a report which will include Circuit Diagrams, Design, Working Mechanism and Results etc. in appropriate format

Text Book(s):

Kothari D. P. & Nagrath I. J., "Basic Electrical and Electronics Engineering", Tata McGraw-Hill

Education

Theraja B.L. and Theraja A.K., "A Textbook of Electrical Technology: Basic Electrical Engineering" in S.I. System of Units, 23rd ed., New Delhi: S. Chand, 2002.

A.P.Malvino, Electronic Principles,7thEdition, Tata McGraw Hill,2007

J. Millman, C. C. Halkias and C. D. Parikh, "Millman's Integrated Electronics", McGraw Hill Education, 2nd Edition.

Basics of Electrical & Electronics Laboratory Manual.
Reference Book (s): John Hiley, Keith Brown and Ian McKenzie Smith, "HUGHES Electrical and Electronic Technology", 10th Edition (Indian Edition published by Dorling Kindersley), Pearson,2011 Samarajit Ghosh, "Fundamentals of Electrical and Electronics Engineering", 2nd Edition, Prentice Hall India, 2007. K Uma Rao, A Jaya Lakshmi, "Basic Electrical engineering" IK International publishing house Pvt. Ltd R. L. Boylestad and L. Nashelsky, "Electronic Devices and Circuit Theory", Pearson Education India 7th Edition. A K. Maini, V. Agrawal, "Electronic Devices & Circuits", Wiley, 2nd Edition A.S Sedra, K. C. Smith, "Microelectronic Circuits", Oxford University Press, 6th Edition Online Resources (e-books, notes, ppts, video lectures etc.): https://presidencyuniversity.linways.com https://www.digimat.in/nptel/courses/video/108105112/L01 "Fundamentals of Electrical Engineering-Basic Concepts, Examples" Seminar Topic: https://nptel.ac.in/courses/108/105/108105153/ "Electrical Measurements" Video lectures on "Electronic Devices" by Prof. Dr. A. N. Chandorkar, IIT Bombay http://www.satishkashyap.com/2013/03/video-lectures-on-electron-devices-by.html Video lectures on "Analog Electronics" by Prof. S.C. Dutta Roy, IIT Delhi https://nptel.ac.in/courses/108/102/108102095/ Video lectures on "Diodes", by Prof. Chitralekha Mahanta, IIT Guwahati, https://nptel.ac.in/courses/117/103/117103063/ E-content: "Introduction to Electrical Machines https://nptel.ac.in/courses/108/102/108102146/" M. -Y. Kao, H. Kam and C. Hu, "Deep-Learning-Assisted Physics-Driven MOSFET Current Voltage Modeling," in IEEE Electron Device Letters, vol. 43, no. 6, pp. 974-977, June 2022, doi: 10.1109/LED.2022.3168243 https://ieeexplore-ieee-org-resiuniv.knimbus.com/document/9758727 F. Bonet, O. Aviñó-Salvadó, M. Vellvehi, X. Jordà, P. Godignon and X. Perpiñà, "Carrier Concentration Analysis in 1.2 kV SiC Schottky Diodes Under Current Crowding," in IEEE Electron Device Letters, vol. 43, no. 6, pp. 938-941, June 2022, doi: 10.1109/LED.2022.3171112. https://ieeexplore-ieeeorg-presiuniv.knimbus.com/document/9764749 M. Chanda, S. Jain, S. De and C. K. Sarkar, "Implementation of Subthreshold Adiabatic Logic for Ultralow-Power Application," in IEEE Transactions on Very Large Scale Integration (VLSI) Systems, vol. .23, no. 12, pp. 2782-2790, Dec. 2015. https://ieeexplore.ieee.org/document/7018053 R. Raut and O. Ghasemi, "A power efficient wide band trans-impedance amplifier in submicron

CMOS integrated circuit technology," 2008 Joint 6th International IEEE Northeast Workshop on Circuits and Systems and TAISA Conference, 2008, pp. 113-116, doi: 0.1109/NEWCAS.2008.4606334. https://ieeexplore.ieee.org/document/4606334
Topics relevant to "SKILL DEVELOPMENT": Performing suitable experiments to compute the electric circuit parameters, performance operation of machines, and operation of semiconductor devices for Skill Development through Participative Learning techniques. This is attained through assessment component mentioned in course plan.

Course Code: LAW7601	Course Title: Indian Constitution Type of Course: Theory	L-T- P-C	1	0	0	0
Version No.						
Course Prerequisites	NIL					
Anti-requisites	NIL					
Course Description	The purpose of this course is to introduce the students to the theory, concepts and practice of Constitution of India which is the law of the land. Further, the course aims at acquainting the students with basic approaches and methodologies to analyse and decide on the ethical dilemma in the field of engineering. The course is both conceptual and analytical. The course develops critical thinking skills by augmenting the student's ability to comprehend the conceptual and legal framework of Constitution of India. Ethics and values are very beautifully weaved into the tapestry of the Indian Constitution. Therefore, the course provides an introduction to the essential theoretical basis of engineering ethics and its application engineers' through a range of industry relevant topics as responsibility for safety and risks, responsibility of employers, rights of engineers etc.					
Course Objective	1. To introduce the students to the conceptual framework of Constitution of India and engineering ethics. 2. To enhance the practical knowledge on responsibility of engineering professionals as citizens of India. 3. To acquaint the student with the relevant contemporary issues surrounding constitutional values and professional ethics. 4. To orient the students about the ethical concepts and frameworks enabling them to identify the codes and moral values relevant to the professional world.					

Course Outcomes	On successful completion of this course the students shall be able: To understand foundational Indian constitutional law concepts and values. To identify the different pillars of democracy and their functions. To analyse the role of the engineers' responsibility in ensuring safety of the society and the employer.			
Module 1	Introduction to the Indian Constitution	Knowledge	Quiz	5 Classes
Course Content:				
Meaning of Constitution, Constitutional Law and Constitutionalism, India before and after adoption of Constitution, Preamble, Salient Features, Concept and Relevance of Fundamental Rights, Fundamental Duties and Directive Principles of State Policy in brief.				
Module 2	Pillars of Democracy: Legislature Executive and Judiciary	Knowledge	Short Essay	5 Classes
Federalism, Union and State Executive, Parliament and State Legislature, Union and State Judiciary, Amendment of the Constitution				
Module 3	Engineering Ethics	Analysis	Presentation on conceptual understanding and problem based scenarios	5 Classes
Scope & Aims of Engineering & Professional Ethics, Code of Ethics as defined in the website of Institution of Engineers (India), Profession, Professionalism, and Professional Responsibility, Conflicts of Interest, Engineering Standards, the impediments to Responsibility, IPRs (Intellectual Property Rights), Necessity of responsible experimentation ,Case Studies on Challenger, Chernobyl, and Boeing.				
Project work/Assignment: Quiz on Fundamental Rights, Short Essay on Judicial Activism in India, Problem based assignments of engineering ethics.				

Resources: 1. M.P. Jain, Indian Constitutional Law, 8th Edition, Lexis Nexis, 2022. 2. M.W. Martin and R. Schinzinger, Ethics in Engineering, 4thEdition, McGraw Hill Education, 2015.
References: Durga Das Basu, Commentary on the Constitution of India, 9th Edition, Lexis Nexis, 2019. Rowan, John, and Zinaich Jr., Ethics for the Professions, Wadsworth, 2003. R.C. Sekhar, Ethical Choices in Business, Response Books, Sage Publications, 1997.

Course Code: CSE2201	Course Title: Program Solving Using C Lab Type of Course: Lab	L- T-P-C	0	0	4	2
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	The course is designed to provide complete knowledge of C language. Students will be able to develop logics which will help them to create programs and applications in C. ACAlso by learning the basic programming constructs they can easily switch over to any other language in future.					
Course Object	The objective of the course is to familiarize the learners with the concepts of Problem Solving Using C and attain Employability through Problem Solving Methodologies.					
Course Outcomes	On successful completion of this course the students shall be able to: Write algorithms and to draw flowcharts for solving problems Demonstrate knowledge and develop simple applications in C programming constructs Develop and implement applications using arrays and strings					

	Decompose a problem into functions and develop modular reusable code Solve applications in C using structures and Union Design applications using Sequential and Random Access File Processing.
Course Content:	

List of Practicals:

Lab Sheet 1: 10 Sessions

Program 1: Sum of Two Numbers

Program 2: Find the Greatest of Three Numbers

Program 3: Check Even or Odd using Conditional Operator

Program 4: Print Multiplication Table using Loop

Program 5: Count Digits in a Number using While Loop

Program 6: Demonstration of Preprocessor Directives

Program 7: Simple Calculator using Switch Case

Lab Sheet 2: 10 Sessions

Program 1: Check Whether a Number is Positive, Negative or Zero

Program 2: Find the Sum of First N Natural Numbers

Program 3: Check Whether a Number is Prime or Not

Program 4: Find Factorial of a Number

Program 5: Reverse a Number

Program 6: Simple Number Guessing Game

Lab Sheet 3: 10 Sessions

Program 1: Linear Search in a One-Dimensional Array

Program 2: Bubble Sort on an Integer Array

Program 3: Matrix Addition (2D Arrays)

Program 4: Count Vowels in a String

Program 6: Selection Sort on an Array

Lab Sheet 4: 10 Sessions

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

Program 2: Factorial Using Recursion

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

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

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

Program 6: Accessing Array Elements Using Pointers

Lab Sheet 5: 10 Sessions

Program 1: Basic Structure Usage

Program 2: Input and Display Array of Structures

Program 3: Array Inside Structure (Student Marks)

Program 4: Structure with Nested Structures (Date of Birth)

Program 5: Union Example and Member Access

Lab Sheet 6: 10 Sessions

Program 1: Write to a File (Text Mode)

Program 2: Read from a File (Text Mode)

Program 3: Append Data to a File

Program 4: Count Characters, Words and Lines in a File

Program 5: Write and Read Structure to/from a Binary File

Program 6: Random Access in File (Update a Record)

Text Book(s):

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

Reference Book(s):

Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.

ReemaThareja, "Programming in C", Oxford University Press, Second Edition, 2016.

Kernighan, B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2015

Schildt Herbert, "C: The Complete Reference", Tata McGraw Hill Education, 4th Edition, 2014.

Stephen G. Kochan, "Programming in C", Addison-Wesley Professional, 4th Edition, 2014.

Web Links and Video Lectures:

https://nptel.ac.in/courses/106/105/106105171/

https://archive.nptel.ac.in/courses/106/104/106104128/

Course Code: CHE2502	Course Title: Chemistry of Smart Materials Lab Type of Course: Laboratory – BSC	L-T-P- C	0	0	2	1
Version No.	1.0					
Course Pre-requisites	Before undertaking this Chemistry of Smart Materials Lab course, students are expected to possess foundational knowledge of chemistry, including an understanding of acids and bases, metals and metal ions, oxidizing and reducing agents, various types of instrumental analysis, and the proper use of laboratory glassware. Additionally, students should be familiar with handling chemicals and glassware safely and adhering to essential laboratory safety precautions.					
Anti-requisites	NIL					
Course Description	The laboratory course aims to develop experimental skills and apply fundamental chemical principles to address chemistry-related problems in engineering. The experiments are carefully designed to complement the theoretical concepts covered in lectures, providing hands-on experience to deepen understanding and reinforce learning. This course is designed to cater to Environment and Sustainability.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of "Chemistry of Smart Materials Lab" and attain SKILL DEVELOPMENT through EXPERIENTIAL LEARNING techniques.					
Course Outcomes (COs)	On successful completion of the course, students shall be able to: CO1: recognize the basic techniques and instrumentation used in chemistry laboratories for quantitative analysis. CO2: estimate the presence of acids and metal ions in domestic and industrial waste using laboratory techniques. CO3: review the experimental results and demonstrate improved experimental skills through hands-on laboratory experience. CO4: classify laboratory techniques such as experimental setups for synthesis, purification, recovery and analysis.					
Course Content:	Total 30 sessions					

Experiment 1	Experimental	Data Collection	Analysis and Interpretation
Determination of strength of strong acid in battery electrolyte using conductometric sensors.			
Experiment 2	Experimental	Data Collection	Analysis and Interpretation
Estimation of iron from e-waste using Electrochemical sensors.			
Experiment 3	Experimental	Data Collection	Analysis and Interpretation
Determination of pKa of organic acid of battery electrolyte using pH sensor.			
Experiment 4	Experimental	Data Collection	Analysis and Interpretation

Estimation of copper from PCBs by using colorimeter (Optical Sensor).

Experiment 5	Experimental	Data Collection	Analysis and Interpretation
Conductometric estimation of mixture of acids in Recycling process of E- waste.			
Experiment 6	Experimental	Data Collection	Analysis and Interpretation
Determination of viscosity coefficient of a given organic liquid using Ostwald's Viscometer (viscoelastic property).			
Experiment 7	Experimental	Data Collection	Analysis and Interpretation
Recovery of valuable metals (copper) from e- waste by Iodometric titration.			
Experiment 8	Experimental	Data Collection	Analysis and Interpretation
Estimation of iron in electronic devices using Std. Potassium permanganate solution.			
Experiment 9	Experimental	Data Collection	Analysis
Flame photometric estimation of sodium (Battery Recycling- Optical Sensor).			
Experiment 10	Experimental	Data Collection	Analysis
Synthesis of conducting polyaniline for gas sensor applications (Demonstration experiment).			
Experiment 11	Experimental	Data Collection	Analysis
Green synthesis of nanomaterials (Demonstration experiment).			
Experiment 12	Experimental	Data Collection	Analysis
Recovery of valuable metals from e- waste by eletroless method (Demonstration experiment).			
Any 8 experiments will be conducted out of 12			
Continuous Internal Assessment: Midterm exam Experimental Evaluation Viva-voce Endterm exam			
Text Book Lab manual for Engineering chemistry by B. Ramadevi and P. Aparna, S. Chand Publications, New Delhi (2022)			

Vogel’s text book of practical organic chemistry 5th edition Inorganic Quantitative analysis by A.I. Vogel, ELBS Publications. College Practical Chemistry by V.K. Ahluwalia, Narosa Publications Ltd. New Delhi
References 1. Engineering Chemistry Laboratory Manual (English, Paperback, Dr Manoj Kumar Solanki), Edu-creation Publishing E-resources: https://books-library.net/files/download-pdf-ebooks.org-kupd-679.pdf Video Links: https://www.youtube.com/watch?v=gd1YQr-74sw https://www.youtube.com/watch?v=wVJ8WQax0rQ https://www.youtube.com/watch?v=aWwEGCNtKwk https://www.youtube.com/watch?v=JhBs_8DrPYo https://www.youtube.com/watch?v=5bFAx2b_6A8 https://www.youtube.com/watch?v=_IVVZnAFfrM https://www.youtube.com/watch?v=BBhuXOh9vOM https://www.youtube.com/watch?v=j-nW3Jhc794
The topics related to Skill Development All the experiments are relevant to Skill Development through Experiential Learning Techniques. This is attained through assessment component mentioned in course handout.

Course Code: PPS1026	Course Title: Industry Readiness Program – II Type of Course: Practical Only Course	L- T - P- C	0	0	2	0
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	This course is designed to enable students learn styles of communication, team building and use empathy in leadership. The course will benefit learners in preparing themselves effectively through various activities and learning methodologies.					

Course Objective	The objective of the course is to familiarize the learners with the concepts of "Industry Readiness for Young Professionals" and attain SKILL DEVELOPMENT through PARTICIPATIVE LEARNING techniques.		
Course Out Comes	On successful completion of this course the students shall be able to: CO 1 Apply different communication skills for success in workplace CO 2 Practice team building skills for career success CO3 Demonstrate ethical leadership skills in workplace		
Course Content			
Module 1	Effective Communication	Classroom activities	10 Hours
Topics: Practice effective communication skills (Verbal, Non-verbal, Written and Visual) Activity: Use social media prompts to prepare self-introduction videos			
Module 2	Team Building	Group Activity	10 Hours
Topics: Skills of an effective team player Activity: Student group activity to build class networking			
Module 3	Leadership	Case study	10 Hours
Topics: Types of leadership, using empathy in leadership Activity: Individual presentation by students on corporate leaders.			
Faculty : L&D			
Targeted Application & Tools that can be used: TED Talks You Tube Links Activities			

Assignment proposed for this course Assignment 1: One minute reel Assignment 2: Team building assignment
Continuous Individual Assessment Module 1: L-S-R-W class assessment Module 2: Team Presentation Module 3: Individual Assessment

The topics related to skill development: Students acquire knowledge on effective communication skills, team building skills and how to prepare themselves to be leaders in workplace using empathy and implement various skill sets during the course of their time in the university.

Course Code EEE1250	Course Title: Basics of Electrical and Electronics Engineering Lab Type of Course: Professional Core – Laboratory	L-T- P-C	0	0	2	1
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					

Course Description	This fundamental laboratory provides an opportunity to validate the concepts taught in the basics of electrical and electronics engineering and enhances the ability to visualize real system performance, using both hardware and simulation tools.
Course Objective	The objective of the course is to familiarize the learners with the concepts of Basics of Electrical and Electronics Engineering and attain Skill Development through Experiential Learning techniques.
Basic skill sets required for the laboratory:	
	The students shall be able to develop: An attitude of enquiry. Confidence and ability to tackle new problems. Ability to interpret events and results. Ability to work as a leader and as a member of team. Assess errors and eliminate them. Observe and measure physical phenomenon. Write Reports. Select suitable equipment, instrument and materials. Locate faults in systems. Manipulative skills for setting and handling equipment. The ability to follow standard test procedures. An awareness of the need to observe safety precautions. To judge magnitudes without actual measurement.
Course Out Comes	On successful completion of the course the students shall be able to: Apply basic laws of Electrical Engineering to compute voltage, currents, and other parameters in the circuits. Demonstrate the working of electrical machines to observe performance characteristics. Demonstrate the working of electronic circuits to obtain the V-I Characteristics of various semiconductor devices. Sketch the characteristics and waveforms relevant to standard electrical and electronic circuits
Course Content:	
	List of Laboratory Tasks: Experiment No 1: Verification of KVL and KCL for a given DC circuit. Level 1: Study and Verify KVL and KCL for the given electrical Circuit. Level 2: For the same circuit considered in level 1, perform the simulation using NI LabVIEW/Multisim/MATLAB. Experiment No 2: Analyse AC series circuits – RL, RC and RLC .

	Level 1: Conduct an experiment to perform and verify the impedance, current and power of Series RL and RC circuits Level 2: Conduct an experiment to perform and verify the impedance and current of RLC series circuits. Experiment No 3: Calculation of power and power factor of the given AC Circuit. Level 1: Conduct an experiment to measure the power and power factor for given resistive load. Level 2: Conduct an experiment to measure the power and power factor for given inductive load. Experiment No 4: Perform the experiments on given Transformer. Level 1: Verify the EMF equation of a transformer and compute the voltage transformation ratio. Level 2: Study the effect of load on the secondary side of the transformer and verify the EMF equation under load conditions. Experiment No 5: Load test on DC shunt motor Level 1: Conduct load test on DC shunt motor and find its efficiency at different loads Level 2: Conduct load test on DC shunt motor and plot the performance characteristics. Experiment 6: Study of PN-Junction Diode Characteristics in Forward and Reverse Bias Conditions. Level 1: Carry out an experiment to plot VI Characteristics and hence find the cut-in voltage on forward characteristics for the Silicon P-N Junction diode. Level 2: Carry out an experiment to plot VI Characteristics of Zener diode and hence find the zener voltage on reverse characteristics for the Silicon P-N Junction zener diode. Experiment No. 7: To observe the output waveform of half wave and full wave rectifier circuit and compute ripple factor and efficiency Level 1: Identify the components required for a rectifier circuit, rig up the circuit, and sketch the output waveforms without filter. Level 2: Rig up the rectifier circuit with RC filter, observe the output waveforms, determine the efficiency and ripple factor. Experiment 8: To construct clipping and clamping circuits for different reference voltages and to verify the responses. Level 1:Identify the components required for building a Clipper / Clamper circuit. Rig up the circuit according to the circuit diagram given and sketch the output waveform. Level 2: Given a sinusoidal input of 10 V p-p, implement a positive / negative clipper with output clipped at 2 V. Experiment 9: To calculate various parameters of emitter follower circuit using BJT

	Level 1: Identify the components required to implement an emitter follower circuit. Rig up the circuit and observe the variations in output waveform with respect to the variations in input waveform. Level 2: Determine the values of Zin input impedance and Zout output impedance for Emitter Follower. Experiment 10: To Implement RC Coupled amplifier using a BJT and sketch the frequency response. Level 1: Identify the components required to implement an RC coupled amplifier circuit. Rig up the circuit and sketch the frequency response. Level 2: From the frequency response curve determine the value of the mid band gain and the bandwidth.

Targeted Application & Tools that can be used:

Targeted Applications: Application Area includes all electrical and electronic circuits (power supply unit, regulator unit, embedded devices, hardware electronics etc.). The students will be able to join a profession which involves basics to high level of electronic circuit design.

Professionally Used Software: Multisim/ P Spice

Besides these software tools hardware equipment such as Multimeters, Function Generators, Power Supplies, Oscilloscopes etc., can be used to perform component/circuit testing and analysis.

Course Material

Basics of Electrical and Electronics Engineering Laboratory Manual, Presidency University, Bengaluru.

Text Book:

Kothari D. P. & Nagrath I. J., “Basic Electrical and Electronics Engineering”, Tata McGraw-Hill

Reference Books:

John Hiley, Keith Brown and Ian McKenzie Smith, "HUGHES Electrical and Electronic Technology", 10th Edition (Indian Edition published by Dorling Kindersley), Pearson,2011

Samarajit Ghosh, "Fundamentals of Electrical and Electronics Engineering", 2nd Edition, Prentice Hall India, 2007.

K Uma Rao, A Jaya Lakshmi, “Basic Electrical engineering” IK International publishing house Pvt. Ltd

R. L. Boylestad and L. Nashelsky, “Electronic Devices and Circuit Theory”, Pearson Education India 7th Edition.

A K. Maini, V. Agrawal, “Electronic Devices & Circuits”, Wiley, 2nd Edition

A.S Sedra, K. C. Smith, “Microelectronic Circuits”, Oxford University Press, 6th Edition

Online Learning Resources:

https://presidencyuniversity.linways.com

https://www.digimat.in/nptel/courses/video/108105112/L01 “Fundamentals of Electrical Engineering-Basic Concepts, Examples”

Video lectures on “Diodes”, by Prof. Chitralekha Mahanta, IIT Guwahati,

https://nptel.ac.in/courses/117/103/117103063/

Topics relevant to “SKILL DEVELOPMENT”: All the experiments which are listed are for Skill Development through Experiential Learning Techniques. This is attained through the assessment component mentioned in course handout.

Course Code: ECE1511	Course Title: Design Workshop			L- T-P- C	1	0	2	2
Version No.	1.0							
Course Pre-requisites	NIL							
Anti-requisites	NIL							
Course Description	This course is designed to provide an in-depth understanding of Arduino, microcontrollers Raspberry pi and their application in various real time projects involving sensors. Throughout the course, students will learn the fundamentals of Arduino and Raspberry Pi programming and gain hands-on experience with a wide range of sensors. Students will explore how to connect and interface sensors with Arduino and Raspberry Pi boards, read sensor data, and use it to control various output devices This course is suitable for beginners who are interested in exploring the world of electronics and developing practical applications using Arduino, Raspberry Pi and sensors.							
Course Objective	The objective of the course is Employability Skills of student by using PARTICIPATIVE LEARNING techniques.							
Course Outcomes	On successful completion of the course the students shall be able to Explain the main features of the Arduino & the Raspberry Pi prototype board. Demonstrate the hardware interfacing of the peripherals to Arduino and Raspberry Pi system. Understand the types of sensors and its functions Demonstrate the functioning of live projects carried out using Arduino and Raspberry Pi system.							
Course Content:								
Module 1	Basic concepts of Microcontrollers	Hands-on	Interfacing Task and Analysis	3 Sessions				
Topics: Introduction to Arduino, ESP and Node MCU Pin configuration and architecture, Device and platform features, Concept of digital and analog ports, Familiarizing with Arduino Interfacing Board, API’s , Introduction to Embedded C and Arduino platform, Arduino Datatypes and variables, Arduino i/o Functions, Arduino Communications, Arduino IDE, Various Cloud Platforms.								

Module 2	Sensory Devices	Hands-on	Interfacing Task and Analysis	3 Sessions

Arduino Sensors: Humidity Sensor, Temperature Sensor, Water Detector / Sensor, PIR Sensor, Ultrasonic Sensor, Connecting Switches and actuators, sensor interface with Arduino.

Introduction to 3D Printer: 3D Printer technology and its working Principles, Applications. Introduction to online Simulators: Working with AutoCAD/Fusion 360 Simulator.

Module 3	Introduction to Micro python	Hands-on	Interfacing Task and Analysis	4 Sessions

Topics:

Introduction to MicroPython, Comparison with other programming languages, Setting up the MicroPython development environment, Basics of MicroPython syntax and structure.

Module 4	Working with Raspberry-pi	Hands-on	Interfacing Task and Analysis	5 Sessions

Introduction to raspberry pi boards, pin-diagram, different types of raspberry pi boards and its application, LED and switch control. Mastering Modules, Setup Raspberry - PuTTY SSH,VNC Viewer to interface with more complicated sensors and actuators. Various Libraries and its functions.

Lab: Name of the Experiments:

Introduction Lab 1:

Level 1: Overview on Arduino based Micro-controller, and sensors.

Level 2: Interfacing of Arduino and ESP boards with sensors and other components.

Lab 2: Smart Plant Monitoring

Level 1- Push button-controlled LED.

Level 2- Automatic Irrigation and monitoring System using Arduino

Lab 3: Robotics with Arduino.

Level 1- Servo Motor control using Arduino

Level 2: DC Motor Control Using Arduino for Robotics.

Lab 4: Environmental pollution using ESP.

Level 1 - IoT based air Pollution Monitoring System.

Level 2- IoT Based water pollution system

Introduction Lab for raspberry pi:

Level 1: Overview on Different Raspberry Pi Boards, and sensors.

Level 2: Configuring the Raspberry Pi and Interfacing with sensors and other components.

Lab 7: Raspberry Pi based Object Detection using TensorFlow and OpenCV. Lab 8: Speech Recognition on Raspberry Pi for Voice Controlled Home Automation. Lab 9: Design the website using HTML and CSS, and host the website on Raspberry Pi. Introduction Lab for 3D printing: Overview of 3D printing. Design of 3D structure using the CAD. Understand the steps of fabrication of simple rectangular box using 3D printer. Lab 10: Design and print of Hollow Cylindrical structure using 3D CAD and 3D printer. Lab 11 Demonstration of Jetson nano board and its capability. (OPTIONAL) Lab 12: Revision Lab 13: Revision Lab 14: Mini Project Lab 15: Mini Project Evaluation.
Topics: Types of Arduino boards, Thonny Python, Python IDLE, sensors, 3D Printer
Targeted Application & Tools that can be used: Application Area: Home Automation, Environmental Monitoring, Agriculture and Farming, Industrial Automation, Internet of Things (IoT), Robotics, Wearable Devices, Security Systems, Education and Learning. These are just a few examples of the many application areas where Arduino, Raspberry Pi and sensors can be applied. The flexibility and affordability of Arduino, and Raspberry Pi combined with the wide range of sensors available, allow for endless possibilities in creating innovative projects. Professionally Used Software: Students can use open SOURCE Software’s Arduino IDE and Tincker CAD, Thonny Python, Python IDLE etc.
Project work/Assignment:
1. Projects: At the end of the course students will be completing the project work on solving many real time issues. 2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link . 3. Presentation: There will be a presentation from interdisciplinary students group, where the students will be given a project on they have to demonstrate the working and discuss the applications for the same
Textbook(s): Monk Simon “Programming Arduino: Getting Started with Sketches”, Mc Graw Hill Publications Second Edition Monk Simon “Raspberry Pi Cookbook: Software and Hardware Problems and Solutions", Publisher(s): O'Reilly Media, Inc. ISBN: 9781098130923 fourth Edition. References

Reference Book(s)

1. Neerparaj Rai “Arduino Projects for Engineers” BPB publishers,first edition, 2016.

2. Ryan Turner ”Arduino Programming ” Nelly B.L. International Consulting Ltd. first edition,2019.

3. Charles Bell Micro Python for the Internet of Things: A Beginner’s Guide to Programming with Python on Microcontrollers" by” Edition 1, 2017, ISBN 978-1-4842-3123-4

4. Stewart Watkiss “Learn Electronics with Raspberry Pi ” Apress Berkeley, CA . second edition,2020. ISBN978-1-4842-6348-8

5. Jo Prusa, “Basic of 3D printing”, Prusa Research, 3rd edition.

6. Volker Ziemann, “A Hands-On Course in Sensors Using the Arduino and Raspberry Pi (Series in Sensors)”, CRC Press, 1st Edition. 2018.

Online Resources (e-books, notes, ppts, video lectures etc.):

Arduino trending Projects < https://www. https://projecthub.arduino.cc/>

Introduction to Arduino < https://onlinecourses.swayam2.ac.in/aic20_sp04/preview>

Case studies on Wearable technology< https://www.hticiitm.org/wearables>

Raspberry-pi Projects < https://magpi.raspberrypi.com/articles/category/tutorials/>

Introduction to internet of things< https://nptel.ac.in/courses/106105166>

E-content:

Cattle Health Monitoring System Using Arduino and IOT (April 2021| IJIRT | Volume 7 Issue 11 | ISSN: 2349-6002)

M H Hemanth Kumar, Ravi Pratap Singh, Nishu Sharma, Pragya Singh” IOT BASED SMART SECURITY SYSTEM USING ARDUINO” 2021 JETIR August 2021, Volume 8, Issue 8.

R. Maheswar, P. Jayarajan, S. Vimalraj, G. Sivagnanam, V. Sivasankaran and I. S. Amiri, "Energy Efficient Real Time Environmental Monitoring System Using Buffer Management Protocol," 2018, pp. 1-5, doi: 10.1109/ICCCNT.2018.8494144. https://ieeexplore.ieee.org/document/8494144.

Yaser S Shaheen,Hussam., " Arduino Mega Based Smart Traffic Control System ," December 2021 Asian Journal of Advanced Research and Reports 15(12): 43-52, 2021(15(12): 43-52, 2021):15(12): 43-52, 2021.

Basil, Eliza Sawant, S.D. “IoT based traffic light control system using Raspberry Pi “ DOI 10.1109/ICECDS.2017.8389604

Supriya S, 2Dr. Aravinda " Green leaf disease detection and identification using Raspberry Pi https://www.irjet.net/archives/V9/i8/IRJET-V9I847.

Dr. E.N. Ganesh., “Health Monitoring System using Raspberry Pi and IOT" DOI : http://dx.doi.org/10.13005/ojcst12.01.03

Topics relevant to development of “SKILL”: System design for achieving Sustainable

Development Goals.

<table>
<tr><td>Course Code:
MAT2303</td><td colspan="2">Course Title: Linear Algebra and Vector Calculus
Type of Course:1] School Core</td><td>L-T- P- C</td><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Version No.</td><td></td><td colspan="6">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td></td><td colspan="6">MAT2301</td></tr>
<tr><td>Anti-requisites</td><td></td><td colspan="6">NIL</td></tr>
<tr><td>Course Description</td><td></td><td colspan="6">This course explores the fundamental concepts of vectors, matrices, and their operations within the context of calculus, including vector differentiation and integration, while applying these tools to solve problems related to linear systems, transformations, and geometric interpretations in higher dimensions, often with applications in fields like physics, engineering, and computer graphics; key topics include vector algebra, matrix operations, determinants, eigenvalues, eigenvectors, gradients, divergence, curl, line integrals, surface integrals, and the fundamental theorems of vector calculus like Green's Theorem, Stokes' Theorem, and the Divergence Theorem.</td></tr>
<tr><td>Course Objective</td><td></td><td colspan="6">The course is intended to develop computational proficiency involving procedures in Matrices, Linear Algebra and Vector Calculus which are useful to all engineering disciplines. This course is to equip students with the ability to understand and manipulate vectors in multidimensional space, apply matrix operations to solve systems of linear equations, and utilize concepts like gradients, divergence, and curl to analyze physical phenomena, all while developing a strong foundation for applying these tools in various scientific and engineering fields like physics, mechanics, and computer graphics.</td></tr>
<tr><td>Course Out Comes</td><td></td><td colspan="6">On successful completion of the course the students shall be able to:
CO1 - Use matrix methods and certain techniques to solve the system of linear equations and to find eigen values, eigen vectors of a matrix to check whether it is diagonalizable.
CO2 - Understand the abstract notions of vector space and dimensionality of it.
CO3 - find the matrix representation of a linear transformation given bases of the relevant vector spaces.
CO4 - Learn different notions of vector and scalar fields with their properties. Understanding the major theorems (Green's, Stokes', Gauss') and some applications of these theorems.</td></tr>
<tr><td>Course Content:</td><td></td><td colspan="6"></td></tr>
<tr><td>Module 1</td><td colspan="2">Systems of Linear Equations</td><td></td><td colspan="4">Classes)</td></tr>
<tr><td colspan="8">Systems of Linear Equations, Matrices and Elementary Row Operations, Echelon forms, Matrix operations, invertible matrices, Determinants and their properties, Cramer’s Rule, LU-decomposition, Applications of Systems of Linear Equations.</td></tr>
<tr><td>Module 2</td><td colspan="2">Vector Space</td><td>Assignment</td><td colspan="4">(15 Classes)</td></tr>
<tr><td colspan="8">Linear Combinations and Linear Independence, Vectors in n Rn, Linear Combinations, Linear Independence Vector Spaces, Definition of a Vector Space, Subspaces, Basis and Dimension, Coordinates and Change of Basis, Orthogonal bases and orthogonal projections.</td></tr>
</table>

Module 3	Linear Transformations		(15 lectures)
Linear Transformations, Algebra of transformations, The Null Space and Range, Isomorphisms, Matrix Representation of Linear Transformations, Similarity Eigenvalues and Eigenvectors, Eigen values and Eigen vectors, Diagonalization. Inner Product Spaces, The Dot Product on Rn and Inner Product Spaces, Orthonormal Bases, Orthogonal Complements, Application: Least Squares Approximation, Diagonalization of Symmetric Matrices, Application: Quadratic Forms. Singular Value Decomposition: Singular values, computing singular value decomposition, and Introduction to principal component analysis.			
Module 4	Vector Calculus	Assignment	(15 lectures)
Vector & Scalar Functions and Fields, Derivatives, Curve, Arc length, Curvature & Torsion, Gradient of Scalar Field, Directional Derivative, Divergence of a Vector Field, Curl of a Vector Field, Physical interpretation, solenoidal and irrotational vector fields. Problems. Line Integrals, Path Independence of Line Integrals, Green`s Theorem in the plane, Surface Integrals, Divergence Theorem of Gauss, Stokes`s Theorem.			
Targeted Application & Tools that can be used: Solve systems of linear equations using various methods including Gaussian and Gauss Jordan elimination and inverse matrices. Perform matrix algebra, invertibility, and the transpose and understand vector algebra in Rn. Determine relationship between coefficient matrix invertibility and solutions to a system of linear equations and the inverse matrices. Find eigenvalues and eigenvectors and use them in applications. Find the dimension of spaces such as those associated with matrices and linear transformations. Understand real vector spaces and subspaces and apply their properties. Compute inner products in a real vector space and compute angle and orthogonality in inner product spaces. Create orthogonal and orthonormal bases: Gram-Schmidt process and use bases and orthonormal bases to solve application problems. Prove basic results in linear algebra using appropriate proof-writing techniques such as linear independence of vectors; properties of subspaces; linearity, injectivity and subjectivity of functions; and properties of eigenvectors and eigenvalues.			
Assignment:			
Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding the applications of Linear Algebra and Vector Calculus to engineering applications – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus of Linear Algebra and Vector Calculus is covered.			
Text Book Gilbert Strang, Linear Algebra and its applications, Wellesley-Cambridge Press,U.S.; 6th edition. B. S. Grewal (2017), Higher Engineering Mathematics by, 44th Edition, Khanna Publishers.			
References: Introduction to Linear Algebra with Application, Jim Defranza, Daniel Gagliardi, Tata McGraw-Hill			

Elementary Linear Algebra, Applications version, Anton and Rorres, Wiley India Edition. Advanced Engineering Mathematics, Erwin Kreysig, Wiley Publication. Elementary Linear Algebra, Ron Larson, Cengage Learning . Linear Algebra and its Applications, David C. Lay, Pearson Education. E-resources/ Web links: https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_9607 https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_143156 https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=CUSTOM_PACKAGE_EBSCO_29052023_270975 https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_94555 https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_243864 https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_224531 NPTEL Video Lectures Matrices and Linear Algebra: https://nptel.ac.in/courses/111106051/ NPTEL Video Lectures Differential Equations: https://nptel.ac.in/courses/111106100/ NPTEL Vector Calculus: https://nptel.ac.in/courses/111/105/111105122/ https://www.math.hkust.edu.hk/~maqian/ma006_0607F.html https://www.scu.edu.au/study-at-scu/units/math1005/2022/
Topics relevant to SKILL DEVELOPMENT: The course focuses on the concepts of Vector calculus and Linear Algebra with reference to specific engineering problems. The course is of both conceptual and analytical type in nature through Problem Solving. This is attained through the assessment component mentioned in the course handout.

Course Code: CSE2251	Course Title: Data Communications and Computer Networks Type of Course: Theory	L- T-P- C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	ECE2022					

Anti-requisites	NIL			
Course Description	The objective of this course is to provide knowledge in data communications and computer networks, its organization and its implementation, and gain practical experience in the installation, monitoring, and troubleshooting of LAN systems. The associated laboratory is designed to implement and simulate various networks using Cisco packet tracer, NS2. All the lab exercises will focus on the fundamentals of creating multiple networks, topologies and analyzing the network traffics.			
Course Objective	The objective of the course is to familiarize the learners with the concepts of Data Communications and Computer Networks and attain Employability through Problem Solving Methodologies.			
Course Outcomes	On successful completion of the course, the students shall be able to: 1] Ilustrate the Basic Concepts Of Data Communication and Computer Networks. 2] Analyze the functionalities of the Data Link Layer. 3] Apply the Knowledge of IP Addressing and Routing Mechanisms in Computer Networks. 4] Demonstrate the working principles of the Transport layer and Application Layer.			
Course Content:				
Module 1	Introduction and Physical Layer- CO1	Assignment	Problem Solving	10 Sessions
Introduction to Computer Networks and Data communications, Network Components – Topologies, Transmission Media –Reference Models -OSI Model – TCP/IP Suite. Physical Layer -Analog and Digital Signals – Digital and Analog Signals – Transmission - Multiplexing and Spread Spectrum.				
Module 2	Reference Models and Data Link Layer – CO2	Assignment	Problem Solving	11 Sessions
Data Link Layer - Error Detection and Correction – Parity, LRC, CRC, Hamming Code, Flow Control and Error Control, Stop and Wait, ARQ, Sliding Window, Multiple Access Protocols, CSMA/CD,CSMA/CA, IEEE 802.3, IEEE 802.11 Ethernet.				
Module 3	Network Layer –CO3	Assignment	Problem Solving	12 Sessions

Network Layer Services - Network Layer Services, Switching Techniques, IP Addressing methods- IPv4 IPV6 – Subnetting. Routing, - Distance Vector Routing – RIP-BGP-Link State Routing –OSPF-Multi cast Routing-MOSPF- DVMRP – Broad Cast Routing. EVPN-VXLAN, VPLS, ELAN.

Module 4	Transport and Application Layer -CO3	Assignment	Problem Solving	12 Sessions

Transport Layers - Connection management – Flow control – Retransmission, UDP, TCP, congestion control, – Congestion avoidance (DECbit, RED)

The Application Layer: Domain Name System (DNS), Domain Name Space, SSH, FTP, Electronic Mail (SMTP, POP3, IMAP, MIME) – HTTP – – SNMP, Web Services, Virtual Networking.

Targeted Application & Tools that can be used: Cisco Packet Tracer, Wireshark, and NS2.

Case Study/Assignment: Choose and analyze a network from any organization/Assignment proposed for this course in CO1-CO4

Problem Solving: Choose and appropriate devices and implement various network concepts.

Programming: Simulation of any network using NS2.

Text Book(s):

1. 1. Behrouz A. Forouzan, “Data Communications and Networking 5E”, 5 th Edition, Tata McGraw-Hill, 2017.

2. Andrew S Tanenbaum, Nick Feamster & David J Wetherall, “Computer Networks” Sixth Edition, Pearson Publication, 2022

Reference(s):

1.References

1. “Computer Networking: A Top-Down Approach”, Eighth Edition, James F. Kurose, Keith W. Ross, Pearson publication, 2021.

2. William Stallings, Data and Computer Communication, 8th Edition, Pearson Education, 2007.

3. Larry L. Peterson and Bruce S. Davie: Computer Networks – A Systems Approach, 4th Edition, Elsevier, 2007.

E- Resources: 1. https://archive.nptel.ac.in/courses/106/105/106105183/ 2. http://www.nptelvideos.com/course.php?id=393 3.https://www.youtube.com/watch?v=3DZLItfbqtQ 4.https://www.youtube.com/watch?v=_fIdQ4yfsfM 5. https://www.digimat.in/keyword/106.html 6. https://puniversity.informaticsglobal.com/login

Course Code: CSE2278	Course Title: Data Structures and Analysis of Algorithm Type of Course: Program core Theory Only	L- T-P- C	3-1-0-4
Version No.			
Course Pre-requisites	NIL		
Anti-requisites	NIL		
Course Description	This course introduces the concepts of abstract data types, data structures, and algorithm design techniques. Students will learn to represent data using arrays, linked lists, stacks, queues, trees, heaps, graphs, and hash tables, and analyze their time and space complexities. Emphasis is placed on the development of efficient algorithms and their correctness using Big-O, Big-Theta, and Big-Omega notations. Students will also explore algorithmic paradigms such as divide-and-conquer, greedy methods, and dynamic programming.		
Course Objective	☐ To understand and implement fundamental data structures such as arrays, linked lists, stacks, queues, trees, heaps, hashing, and graphs. ☐ To analyze the time and space complexity of algorithms using asymptotic notations and solve recurrence relations for algorithm performance evaluation. ☐ To design and apply efficient algorithmic techniques including divide-and-conquer, greedy methods, and dynamic programming for solving real-world computational problems.		
Course Outcomes	Upon successful completion of this course, students will be able to: CO1: Apply suitable data structures for problem solving in software systems. CO2: Analyze the time and space complexity of algorithms using asymptotic notations.		

	CO3: Design efficient algorithms using divide-and-conquer, greedy, and dynamic programming paradigms. CO4: Implement and evaluate algorithms for tree, heap, hashing, and graph-based problems.
Course Content:	

Module 1	Introduction to Data Structures and Algorithm Analysis	6 Hours Lecture + 2 Hours Tutorial
Abstract Data Types (ADT), Time and Space Complexity Asymptotic Notations: Big O, Big Θ, Big Ω Empirical and Mathematical Analysis of Algorithms Recurrence Relations and Solving Techniques		
Module 2	Linear Data Structures	10 Hours Lecture + 4 Hours Tutorial
Arrays, Strings, Linked Lists (Singly, Doubly, Circular) Stacks and Queues: Implementation and Applications Deque, Priority Queue, Applications in Expression Evaluation, Backtracking		
Module 3	Trees and Heaps	10 Hours Lecture + 3 Hours Tutorial
Binary Trees, Traversals (Recursive and Non-recursive) Binary Search Trees (BST), AVL Trees, B-Trees Min-Heap, Max-Heap and Heap Operations Heap Sort and Priority Queue Implementation		
Module 4	Hashing and Searching Techniques	(6 Hours Lecture + 2 Hours Tutorial)
Hash Tables, Hash Functions, Collision Resolution Linear and Binary Search, Interpolation Search Complexity Analysis of Searching Algorithms		
Module 5	Graphs and Traversals	7 Hours Lecture + 2 Hours Tutorial
Graph Representations: Adjacency Matrix/List BFS, DFS, Topological Sort Shortest Path Algorithms: Dijkstra's, Bellman-Ford		
Module 6	Algorithmic Strategies	6 Hours Lecture + 2 Hours Tutorial
Divide and Conquer: Merge Sort, Quick Sort Greedy Method: Kruskal's and Prim's Algorithms Dynamic Programming: Matrix Chain Multiplication, 0/1 Knapsack		

Text Books :Sartaj Sahni, Ellis Horowitz, Fundamentals of Data Structures and Algorithms, Universities Press, 2nd Edition, 2021. ISBN: 9788173716615
Reference Books Thomas H. Cormen et al., Introduction to Algorithms, MIT Press, 3rd Edition, 2009. ISBN: 9780262033848 Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, Pearson, 4th Edition, 2014. ISBN: 9780132847377 Narasimha Karumanchi, Data Structures and Algorithms Made Easy, CareerMonk Publications, 2nd Edition, 2021. ISBN: 9788193245279

Course Code: RAI3405	Course Title: Graph Theory Algorithms for Robotics Type of Course: Theory onlr		L- T - P- C	3	0	0	3
Version No.		1.0					
Course Pre-requisites		-					
Anti-requisites		NIL					
Course Description		This course explores the application of graph theory and graph-based algorithms in the field of robotics. Students will learn how to model environments, robot configurations, and motion planning problems using graph structures. The course covers foundational topics in graph theory, including trees, shortest paths, connectivity, and search algorithms, and extends to advanced topics such as graph-based SLAM (Simultaneous Localization and Mapping), coverage algorithms, networked robot coordination, and topological mapping. Emphasis will be placed on implementing and analyzing algorithms in practical robotic scenarios, including autonomous navigation, path planning, and multi-robot systems.					
Course Objective		• To impart the basic knowledge of Graph theory • To familiarize the concepts of various types of graphs and simple properties • To familiarize with basic results in graph algorithms and apply to network for robotics					
Course Outcomes		On successful completion of the course the students shall be able to: CO1: Apply the concepts of graph theory, shortest path and spanning tree algorithms for real-time problems. CO2: Apply the graph connectivity algorithms for flow problems in robotic networks. CO3: Apply the graph spaces and methods in obstacle avoidance. CO4: Apply the graph theory algorithms for robot motion and path planning.					

Course Content:					
Module 1	Introduction	Participative Learning			11 Sessions
Graphs and Sub graphs, isomorphism, matrices associated with graphs, degrees, walks, connected graphs, Paths and Circuits, Components and Connectedness algorithms, shortest path algorithm.					
Module 2	Tree	Participative Learning			10 Sessions
Tree: Trees, properties of trees, Pedant vertices in a tree, center of a tree, rooted binary trees, spanning trees and minimal spanning tree algorithms, Tree traversals					
Module 3	Graph connectivity	Experiential Learning			12 Sessions
Graph connectivity: Graph connectivity, maximal flow algorithm. Euler and Hamiltonian graphs. Travelling salesman algorithm. Network flow problems, Ford-Fulkerson algorithm.					
Module 4	Planar Graph & Case Study	Experiential Learning			12 Sessions
Planar Graph: Planar graph, Euler theorem and applications of planar graphs. Coloring of graphs. Case Study: Graph theory applications in robotics motion and path planning, collision and obstacle avoidance					
Text Book(s)					
Stanisław Zawiślak, Jacek Rysiński, Graph-Based Modelling in Engineering: 42 (Mechanisms and Machine Science), Springer, 2018. Narsingh Deo, Graph Theory with Applications, PHI, 2008 L.R.Foulds , "Graph Theory Applications", Springer ,2016 Kevin M. Lynch,Frank C. Park, “Modern Robotics: Mechanics, Planning, and Control”, Cambridge University Press, 2017					

Course Code: CSE2255	Course Title: Object Oriented Programming Using Java Type of Course: Theory	L-T- P- C	3	0	0	3
Version No.	2.0					
Course Pre-requisites	CSE1500					
Anti-requisites	Nil					
Course Description	This course introduces the core concepts of object-oriented programming. This course has theory and lab component which emphasizes on understanding the implementation and application of object-oriented programming paradigm. It helps the student to build real time secure applications by applying these concepts and also for effective problem solving. The students interpret and understand the need for object oriented programming to build applications.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Problem-Solving using JAVA and attain SKILL DEVELOPMENT through EXPERIENTIAL LEARNING techniques					
Course Out Comes	On successful completion of the course the students shall be able to: CO1: Describe the basic programming concepts. [Understand] CO2: Apply the concept of classes, objects and methods to solve problems. [Application] CO3: Apply the concept of arrays and strings. [Appy] CO4: Implement inheritance and polymorphism building secure applications. [Apply]					

	CO5: Apply the concepts of interface and error handling mechanism. [Apply]			
Course Content:				
Module 1	Basic Concepts of Programming and Java	Assignment	Problem Solving	9 Sessions
Topics: Introduction to Principles of Programming: Process of Problem Solving, Java program structure, Download Eclipse IDE to run Java programs, Sample program, Data types, Identifiers, Variables, Constants in java, Operators, Assignments and Expression, Basic Input/ Output functions, Control Statements: Branching and Looping.				
Module 2	Classes, objects, methods and Constructors	Assignment	Problem Solving	10 Sessions
Topics: Classes, Objects and Methods: Introduction to object Oriented Principles, defining a class, adding data members and methods to the class, access specifiers, instantiating objects, reference variable, accessing class members and methods. Static Polymorphism: Method overloading, constructors, constructor overloading, this keyword, static keyword, Nested classes, Accessing members in nested classes.				
Module 3	Arrays, String and String buffer	Assignment	Problem Solving	8 Sessions
Topics: Arrays: Defining an Array, Initializing & Accessing Array, Multi –Dimensional Array, Array of objects. String: Creation & Operation. String builder class, methods in String Buffer.				
Module 4	Inheritance and Polymorphism	Assignment	Problem Solving	10 Sessions
Topics: Inheritance: Defining a subclass, Types of Inheritance, super keyword. Dynamic Polymorphism: Method overriding. Final keyword: with data members, with member functions and with class. Abstract keyword: with data members, with member functions and with class, Exception handling.				
Module 5	Input & Output Operation in Java	Assignment	Problem Solving	8 Sessions
Input/output Operation in Java(java.io Package), Streams and the new I/O Capabilities, Understanding Streams, working with File Object, File I/O Basics, Reading and Writing to Files, Buffer and Buffer Management, Read/Write Operations with File Channel, Serializing Objects, Observer and Observable Interfaces.				

Text Book T1 Herbert Schildt, “The Complete Reference Java 2”, Tata McGraw Hill Education, 11th Edition,2019.
References R1. Cay S Horstmann and Cary Gornell, “CORE JAVA volume I-Fundamentals”, Tenth Edition, Pearson 2015. R2: James W. Cooper, “Java TM Design Patterns – A Tutorial”, Addison-Wesley Publishers.4th Edition, 2000. R3. E. Balagurusamy, “Programming with Java”, Tata McGraw Hill Education, 6th Edition, 2019. E book link R1: http://rmi.yaht.net/bookz/core.java/9780134177373-Vol-1.pdf E book link R2: Java(tm) Design Patterns: A Tutorial([PDF] [7qmsenjl97t0] (vdoc.pub) Web resources https://youtube.com/playlist?list=PLu0W_9lII9agS67Uits0UnJyrYiXhDS6q https://puniversity.informaticsglobal.com:2229/login.aspx
Topics relevant to development of “Skill Development”: Static Polymorphism Method overloading, constructors constructor overloading this keyword static keyword and Inner classes Inheritance and Polymorphism. for Skill Development through Experiential Learning techniques. This is attained through assessment component mentioned in course handout.

Course Code: CSE2256	Course Title: Object Oriented Programming Using Java Lab Type of Course: Lab	L-T- P-C	0	0	2	1
Version No.	2.0					
Course Pre-requisites	CSE1500					
Anti-requisites	Nil					
Course Description	This course introduces the core concepts of object-oriented programming. This course has theory and lab component which emphasizes on understanding the implementation and application of object-oriented programming paradigm. It helps the student to build real time secure applications by applying these concepts and also for effective problem solving. The students interpret and understand the need for object oriented programming to build applications.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Problem-Solving using JAVA and attain SKILL DEVELOPMENT through EXPERIENTIAL LEARNING techniques					
Course Out Comes	On successful completion of the course the students shall be able to: CO1: Demonstrate basic programming concepts. [Apply] CO2: Apply the concept of classes, objects and methods to solve problems. [Application] CO3: Apply the concept of arrays and strings. [Appy] CO4: Implement inheritance and polymorphism building secure applications. [Apply] CO5: Apply the concepts of interface and error handling mechanism. [Apply]					
Experiments:						

P1: Programming Exercises on Basic Concepts.

LEVEL 1: Discuss about datatypes and variables.

LEVEL 2: Demonstrate a simple java program

P2: Programming Exercises on Basic Concepts.

LEVEL 1: Discuss about datatypes and variables.

LEVEL 2: Demonstrate a simple java program

P3: Programming Exercises on operators, expressions based on a given scenario.

LEVEL 1: Explain operators, expressions.

LEVEL 2: Demonstrate operators

P4: Programming Exercises Command Line Arguments based on a given scenario.

LEVEL 1: Explain command line arguments

LEVEL 2: Demonstrate command line arguments

P5: Programming Exercises on basic Input/ Output functions and Control Statements: Branching

LEVEL 1: Explain Input/ Output functions

LEVEL 2:Demonstrate Control Statements: Branching

P6: Programming Exercises on Control Statements: Looping

LEVEL 1: Explain variour loops.

LEVEL 2:Demonstrate Control Statements: Looping

P7: Programming Exercises on Creating Objects, classes on a given scenario.

LEVEL 1: Illustrate class, object and methods.

LEVEL 2: Execute java program using class and objects

P8: Programming Exercises on Adding methods and Constructors to the class based on a given scenario.

LEVEL 1: Illustrate methods and constructors

LEVEL 2: Execute java program using methods and constructors

P9: Programming Exercises on methods based on a given scenario.

LEVEL 1: Illustrate method overloading

LEVEL 2: Apply method overloading for the given scenario.

P10: Programming Exercises on methods based on a given scenario.

LEVEL 1: Illustrate constructors overloading

LEVEL 2: Apply constructor overloading for the given scenario

P11: Programming Exercises on methods for static members bassed on a given scenario.

LEVEL 1: Benefits of usage static members

LEVEL 2: Usage of Static Members for the given scenario

P12: Programming Exercises on static methods based on a given scenario.

LEVEL 1: Benefits of usage static methods

LEVEL 2: Usage of Static Methods for the given scenario.

P13: Programming Exercises on nested Classes based on a given scenario.

LEVEL 1: Benefits of usage nested classes

LEVEL 2: Apply the concept of usage of nested classes for the given scenario

P14: Programming Exercises on Arrays and its built-in functions based on a given scenario.

LEVEL 1: Illustrate one dimensional arrays and its functions.

LEVEL 2: Demonstrate programs with single-dimensional arrays and operations.

P15: Programming Exercises on Arrays and its built-in functions based on a given scenario.

LEVEL 1: Illustrate multi dimensional arrays and its functions.

LEVEL 2: Demonstrate programs with multi-dimensional arrays and operations.

P16: Programming Exercises on String Class and its built-in functions based on a given scenario.

LEVEL 1: Explain about String class and String methods.

LEVEL 2: Execute simple java applications for String and StringBuffer operations

P17: Programming Exercises on String Buffer Class and its built-in functions based on a given scenario.

LEVEL 1: Explain about StringBuffer class and String methods.

LEVEL 2: Execute simple java applications for String and StringBuffer operations

P18: Programming Exercises on String Builders and its built-in functions based on a given scenario.

LEVEL 1: Explain about String Builders.

LEVEL 2: Execute java applications for String Builders

P19: Programming Exercises on single, multi level Inheritance and super keyword based on given scenario.

LEVEL 1: Explain single and multi level inheritance.

LEVEL 2: Demonstrate simple applications for the different types of inheritance

P20: Programming Exercises hierarchical Inheritance and super keyword based on given scenario.

LEVEL 1: Explain hierarchical inheritance.

LEVEL 2: Demonstrate simple applications for hierarchical inheritance

P21: Programming Exercises on Overriding.

LEVEL 1: Differentiate method overloading and method overriding.

LEVEL 2: Demonstrate simple program with dynamic method dispatch.

P22: Programming Exercises on Final based on given scenario.

LEVEL 1: Implement programs using concept of final.

LEVEL 2: Use final keyword for the given problem

P23: Programming Exercises on Abstract keyword based on given scenario.

LEVEL 1: Implement programs using concept of Abstract.

LEVEL 2: Use abstract keyword for the given problem

P24: Programming Exercises on Interface based on a given scenario.

LEVEL 1: Differentiate abstract class about interface

LEVEL 2: Implement interfaces in the given problem

P25: Programming Exercises on Exception Handling based on a given scenario.

LEVEL 1: Explain exception handling

LEVEL 2: Solve the given problem using exception handling mechanism.

P26: Programming Exercises on Character Stream Classes based on a given scenario.

LEVEL 1: Explain Character Stream Classes

LEVEL 2: Solve the given problem using Character Stream Class.

P27: Programming Exercises on Read/Write Operations with File Channel based on a given scenario.

LEVEL 1: Explain Read/Write Operations with File Channel

LEVEL 2: Solve the given problem using Read/Write Operations with File Channel.

P28: Programming Exercises on Read/Write Operations with File Channel based on a given scenario.

LEVEL 1: Explain Read/Write Operations with File Channel

LEVEL 2: Solve the given problem using Read/Write Operations with File Channel.

P29: Programming Exercises on Read/Write Operations with File Channel based on a given scenario.

LEVEL 1: Explain Read/Write Operations with File Channel

LEVEL 2: Solve the given problem using Read/Write Operations with File Channel.

P30: Programming Exercises on Read/Write Operations with File Channel based on a given scenario.

LEVEL 1: Explain Read/Write Operations with File Channel

LEVEL 2: Solve the given problem using Read/Write Operations with File Channel.

Targeted Application & Tools that can be used : JDK /Eclipse IDE/Visual Studio Code / net Beans IDE.

Text Book

T1   Herbert Schildt, “The Complete Reference Java 2”, Tata McGraw Hill Education, 11th Edition,2019.

References

R1. Cay S Horstmann and Cary Gornell, “CORE JAVA volume I-Fundamentals”, Tenth Edition, Pearson 2015.

R2: James W. Cooper, “Java TM Design Patterns – A Tutorial”, Addison-Wesley Publishers.4th Edition, 2000.

R3. E. Balagurusamy, “Programming with Java”, Tata McGraw Hill Education, 6th Edition, 2019.

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

E book link R2: Java(tm) Design Patterns: A Tutorial([PDF] [7qmsenjl97t0] (vdoc.pub) Web resources https://youtube.com/playlist?list=PLu0W_9lII9agS67Uits0UnJyrYiXhDS6q https://puniversity.informaticsglobal.com:2229/login.aspx
Topics relevant to development of “Skill Development”: Static Polymorphism Method overloading, constructors constructor overloading this keyword static keyword and Inner classes Inheritance and Polymorphism. for Skill Development through Experiential Learning techniques. This is attained through assessment component mentioned in course handout.

Course Code: ECE2530	Course Title: Embedded Systems using Microcontrollers Type of Course: Program Core Theory	L-T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	ECE2022					
Anti-requisites	NIL					
Course Description	This course provides a comprehensive overview of embedded systems design using microcontrollers, with a special emphasis on applications in robotics and artificial intelligence. The course covers microcontroller architecture, programming in C and assembly, interfacing to real-world sensors and actuators, and the integration of real-time operating systems (RTOS).					

<table>
<tr><td>Course Objective</td><td colspan="4">The objective of the course is to familiarize the learners with the concepts of Embedded Systems and Microcontrollers to improve the learners' Employability Skills by Participative Learning.</td></tr>
<tr><td>Course Outcomes</td><td colspan="4">On successful completion of this course the students shall be able to:

Understand embedded systems and microcontroller architectures, including their relevance in robotics and AI.

Distinguish between various microcontroller families (e.g., ARM Cortex-M, AVR, PIC) and their use cases.

Analyse microcontroller programs using Assembly and C languages to interface with sensors and actuators.

Understand the fundamentals of real-time operating systems (RTOS) and apply them to robotics and AI tasks.</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>Fundamentals of Embedded Systems and Microcontrollers</td><td>Quiz</td><td>Memory Recall based Quizzes</td><td>9 sessions</td></tr>
<tr><td colspan="5">Topics:

Introduction to Embedded Systems and their applications in Robotics and AI, Embedded Processors vs. Microprocessors: Architecture and Applications, Overview of Microcontroller Families: ARM Cortex-M, AVR and PIC, Memory Systems: Flash, SRAM and EEPROM, Basic Peripherals: GPIO, Timers, ADC and DAC, Interfacing the Analogue World: Sensors and Actuators, Interrupts and Exceptions: Basics and Handling.</td></tr>
<tr><td>Module 2</td><td>Microcontroller Architecture and Assembly Programming</td><td>Quiz, Mid Term Exam</td><td>Memory Recall based Quizzes, Mid Term Exam</td><td>12 sessions</td></tr>
<tr><td colspan="5">Topics:

Detailed ARM Cortex-M Architecture: Registers, Bus Systems, and Memory Map, Introduction to AVR and PIC Architectures: Key Differences, ARM and Thumb Instruction Set Overview: Addressing Modes, ARM Cortex-M4 (e.g., TM4C123) vs. LPC21xx Comparison, Assembly Programming Basics for ARM and AVR: Syntax, Directives and Tools, Pipeline and Performance Considerations, Interrupt Vector Table and Exception Handling in Assembly, System Control and Configuration Registers.</td></tr>
</table>

Module 3	Microcontroller Programming and Interfacing	Assignment	Programming Assignment	12 sessions
Topics: Embedded C Programming: Data Types, Pointers and Bitwise Operations, Debugging Techniques: Single Stepping, Breakpoints and Watchpoints, Input/Output Port Concepts and Registers, Interfacing Switches and LEDs: Debouncing and Control Logic, Interfacing DC Motors and Stepper Motors via H-Bridge Drivers, Serial Communication Protocols: UART, SPI, I2C and CAN Bus, USB and RS232 Interfaces for Robotic Controllers, MODBUS Protocol for Industrial Automation Integration, Sensor Interfacing: Ultrasonic, Infrared, IMU and Vision Sensors, PWM Signal Generation for Motor Control and LED Dimming, ADC and DAC Usage for Sensor Data Acquisition and Actuation, Timer and Counter Applications in Robotics.				
Module 4	Real-Time Operating Systems (RTOS) and Applications in Robotics and AI	End Term Exam	End Term Exam	12 sessions
Topics: Introduction to Embedded Real-Time Operating Systems (RTOS), RTOS Types: Cooperative, Preemptive and Hybrid, RTOS Kernel Architecture: Task Management, Scheduling and Context Switching, Overview of FreeRTOS, μC/OS-II and RTLinux, RTOS API: Task Creation, Delays and Synchronization (Semaphores, Mutexes), Interrupt Handling and Deferred Processing, Inter-Task Communication: Queues, Mailboxes and Event Groups, RTOS in Robotics: Implementing Real-Time Control Loops for Motor and Sensor Fusion, Embedded AI: Implementing Basic Neural Network Inference on Microcontrollers, Low-Power Modes and Power Management in RTOS, Case Study: RTOS-Based Drone Flight Controller / Case Study: RTOS-Based Autonomous Mobile Robot.				
List of Laboratory Tasks: Nil				
Targeted Application & Tools that can be used: Targeted Applications: Industry 4.0, Service Robotics, Autonomous Systems, IoT-based AI Edge Devices Professionally Used Software: Keil μVision, STM32CubeIDE, Arduino IDE, MPLAB X				
Text Book(s): Andrew N. Sloss, Dominic Symes, Chris Wright, “ARM System Developer's Guide: Designing and Optimizing System Software”, Morgan Kaufmann, 2nd Edition.				

Jonathan W. Valvano, “Embedded Systems: Introduction to ARM® Cortex™-M Microcontrollers”, CreateSpace Independent Publishing, 3rd Edition. Alexander G. Dean, “Embedded Systems Fundamentals with Arm® Cortex®-M Based Microcontrollers: A Practical Approach”, ARM Education Media, 2nd Edition. Steve Heath, “Embedded System Design”, Elsevier, 2nd Edition.
Reference(s): Reference Book(s): Jonathan W. Valvano, “Embedded Systems: Real-Time Interfacing to Arm® Cortex™-M Microcontrollers”, CreateSpace Independent Publishing, 2nd Edition. K.V.K. Prasad, “Embedded Real-Time Systems: Concepts, Design & Programming”, Dreamtech Press, 3rd Edition. ARM Cortex™-M4/M7 Datasheet and Reference Manual (https://developer.arm.com/) Raymond J.A. Buhr, Donald L. Bailey, “An Introduction to Real-Time Systems: From Design to Networking with C/C++”, Prentice Hall, 1st Edition. Online Resources (e-books, notes, ppts, video lectures etc.): NPTEL: Embedded Systems and IoT Lectures (https://nptel.ac.in/) University of Michigan: EECS 571 Embedded Systems Lecture Notes (http://www.eecs.umich.edu/courses/eecs571/lectures/lecture1-intro.pdf) Texas A&M University: Embedded Systems Course Materials (https://www.tamuc.edu/engineering/) ARM Developer: FreeRTOS Tutorials and Documentation (https://developer.arm.com/) MIT OpenCourseWare: Microcontroller Technologies (https://ocw.mit.edu/) E-content: Joseph Sifakis, “Embedded Systems Design: Scientific Challenges and Work Directions”, 2009 Design, Automation & Test in Europe Conference & Exhibition. (https://ieeexplore.ieee.org/document/5090623) Gabor Karsai; Fabio Massacci; Leon Osterweil; Ina Schieferdecker, “Evolving Embedded Systems”, Computer, Vol. 43, Issue 5. (https://ieeexplore.ieee.org/document/5472888) Yanbing Li; M. Potkonjak; W. Wolf, “Real-Time Operating Systems for Embedded Computing”, IEEE International Conference on Computer Design, 1997. (https://ieeexplore.ieee.org/document/628899)

Sachin P. Kamat, “An Eye on Design: Effective Embedded System Software”, IEEE Potentials, Vol. 29, Issue 5. (https://ieeexplore.ieee.org/document/5568178)
Topics relevant to “EMPLOYABILITY SKILLS”: Interfacing DC and Stepper Motors for Robotic Actuation, Real-Time Sensor Fusion with IMUs and Ultrasonic Sensors, Implementation of Communication Protocols: I2C, SPI, UART, CAN for Autonomous Systems, RTOS Task Scheduling and Real-Time Control for Robotics Applications, Embedded AI Inference on Microcontrollers for Edge Intelligence for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Course Code: ECE2531	Course Title: Embedded Systems using Microcontrollers Lab Type of Course: Program Core Lab	L-T-P-C	0	0	2	1
Version No.	1.0					
Course Pre-requisites	ECE2022, ECE2052, CSE2200 & EEE1200					
Anti-requisites	NIL					
Course Description	This lab course provides hands-on experience in microcontroller-based embedded systems design and implementation. It complements the lecture course by enabling students to apply theoretical concepts through practical work. Students will configure microcontroller peripherals, interface sensors and actuators, implement real-time programming techniques, and execute a mini-project involving robotics or AI applications.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Embedded Systems and Microcontrollers to improve the learners' Employability Skills by Experiential Learning.					
Course Outcomes	On successful completion of this course the students shall be able to: Demonstrate mastery in configuring microcontroller peripherals at register-level. Develop firmware to read sensor data and control actuators in real-time. Analyse embedded hardware/software systems using laboratory instruments.					
Course Content:	NIL					
List of Laboratory Tasks:						

Experiment N0 1: Development environment setup, LED blink demo Experiment N0 2: GPIO configuration for digital input/output, button debouncing Experiment N0 3: Interrupt-driven input handling, external interrupts Experiment N0 4: GPIO-based project: running LED patterns and button control Experiment N0 5: ADC configuration and potentiometer voltage measurement Experiment N0 6: PWM generation for LED brightness control Experiment N0 7: PWM motor control using H-bridge driver Experiment N0 8: Combined ADC-PWM experiment: sensor-based speed control Experiment N0 9: I2C interfacing: MPU-6050 accelerometer demo Experiment N0 10: SPI interfacing: temperature sensor (MAX6675) demo Experiment N0 11: UART-based Bluetooth telemetry (HC-05) implementation Experiment N0 12: SPI-based nRF24L01 wireless communication and PER measurement
Targeted Application & Tools that can be used: Targeted Applications: Industry 4.0, Service Robotics, Autonomous Systems, IoT-based AI Edge Devices Professionally Used Software: Keil µVision, STM32CubeIDE, Arduino IDE, MPLAB X
Text Book(s): Raj Kamal, "Embedded Systems: Architecture, Programming and Design", McGraw Hill, 3rd Edition (2017) Muhammad Ali Mazidi, "The 8051 Microcontroller and Embedded Systems", Pearson, 2nd Edition (2007)
Reference(s): Reference Book(s): Jack Ganssle, "The Art of Designing Embedded Systems", Newnes, 2nd Edition (2008) Wayne Wolf, "Computers as Components: Principles of Embedded Computing System Design", Morgan Kaufmann, 3rd Edition (2012) Jonathan Valvano, "Embedded Systems: Introduction to the MSP432 Microcontroller", CreateSpace (2017) Online Resources (e-books, notes, ppts, video lectures etc.):

IEEE Xplore Digital Library – Embedded Systems & Robotics papers https://ieeexplore.ieee.org/ STMicroelectronics Application Notes (GPIO, ADC, Timers) https://www.st.com/content/st_com/en/support/learning/resources/application-notes.html Texas Instruments E2E™ Forum (peripheral examples) https://e2e.ti.com/ FreeRTOS Documentation & Tutorials https://www.freertos.org/ NPTEL Video Lectures on Embedded Lab Practices https://onlinecourses.nptel.ac.in/ Tinkercad Circuits (simulations) https://www.tinkercad.com/circuits Proteus Simulation Suite (Labcenter Electronics) https://www.labcenter.com/ E-content: Joseph Sifakis, "Embedded Systems Design: Scientific Challenges and Work Directions", 2009 Design, Automation & Test in Europe Conference & Exhibition. (https://ieeexplore.ieee.org/document/5090623) Gabor Karsai; Fabio Massacci; Leon Osterweil; Ina Schieferdecker, "Evolving Embedded Systems", Computer, Vol. 43, Issue 5. (https://ieeexplore.ieee.org/document/5472888) Yanbing Li; M. Potkonjak; W. Wolf, "Real-Time Operating Systems for Embedded Computing", IEEE International Conference on Computer Design, 1997. (https://ieeexplore.ieee.org/document/628899) Sachin P. Kamat, "An Eye on Design: Effective Embedded System Software", IEEE Potentials, Vol. 29, Issue 5. (https://ieeexplore.ieee.org/document/5568178)
Topics relevant to "EMPLOYABILITY SKILLS": Interfacing DC and Stepper Motors for Robotic Actuation, Real-Time Sensor Fusion with IMUs and Ultrasonic Sensors, Implementation of Communication Protocols: I2C, SPI, UART, CAN for Autonomous Systems, RTOS Task Scheduling and Real-Time Control for Robotics Applications, Embedded AI Inference on Microcontrollers for Edge Intelligence for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Course Code:	Course Title: Introduction to Robotics and Automation	L-T-P-C	3	0	0	3

MEC3420	Type of Course: 1] Professional Elective Course 2] Theory			
Version No.	1.0			
Course Pre-requisites	NIL			
Anti-requisites	NIL			
Course Description	This course provides an overview of robot anatomy, motion control system and intelligent controls. A wide scope is given to the area of Applications where in students understand how robotics can be applied in different industrial applications. The course also enhances the practical applications of robots and automation through case studies.			
Course Objective	The objective of the course is to familiarize the learners with the concepts of "Introduction to Robotics and Automation" and attain EMPLOYABILITY SKILLS through Participative Learning techniques.			
Course Out Comes	On successful completion of the course the students shall be able to: 1] Describe Robot, Robotics and Various Components of Robots. 2] Describe various types of sensors, actuators and its applications in robotics. 3] Discuss different type of Automation and applications. 4] Describe the different types of Automated manufacturing systems.			
Course Content:				
Module 1	Introduction to Robotics	Assignment	Data Collection	10 Sessions
Topics: Definition of Robot, History of robotics, Robotics market and the future prospects, Robot Anatomy, Robot configurations: Polar, Cartesian, cylindrical and Jointed-arm configuration. Robot motions, Joints, Work volume, Robot drive systems, End effectors – Tools and grippers.				
Module 2	Robot Sensors and Machine vision system	Assignment	Data Collection	12 Sessions

<table>
<tr><td colspan="5">Topics:

Sensors in Robotics - Tactile sensors, Proximity and Range sensors, use of sensors in robotics. Machine Vision System: Introduction to Machine vision, the sensing and digitizing function in Machine vision, Image processing and analysis, Training and Vision systems. Machine Vision System: Introduction to Machine vision, the sensing and digitizing function in Machine vision.</td></tr>
<tr><td>Module 3</td><td>Introduction to Automation</td><td>Assignment</td><td>Data collection and Analysis</td><td>12 Sessions</td></tr>
<tr><td colspan="5">History of Automation, Reasons for automation, Disadvantages of automation, Automation systems, Types of automation – Fixed, Programmable and Flexible automation, Automation strategies. Industrial Applications of Automation systems.</td></tr>
<tr><td>Module 4</td><td>Automated Manufacturing Systems</td><td>Case Study</td><td>Data collection and analysis</td><td>10 Sessions</td></tr>
<tr><td colspan="5">Components, classification and overview of manufacturing Systems, Flexible Manufacturing Systems (FMS), Types of FMS, Applications and benefits of FMS. Review of NC, CNC, DNC, Adaptive control and robotics in manufacturing. Advantages, disadvantages and applications.</td></tr>
<tr><td colspan="5">Targeted Application & Tools that can be used:

Industrial applications of robots: Pick and place robots, welding and other industrial applications.

Automation in industries.</td></tr>
<tr><td colspan="5">Text Book:

1.Robotics for Engineers by Yoram Koren, Mc Graw-Hill.

2. An Introduction to Automated Process Planning Systems- Tiess Chiu Chang & Richard A. Wysk. Categories.</td></tr>
<tr><td colspan="5">References:

1. Robot Technology by Philippe Coffet (Vol. 1 to Vol. 7)

2. Walking Machines, An introduction to legged Robots by D J Todd

3. Fundamentals of Robot Technology by D J Todd</td></tr>
</table>

4. Introduction to Autonomous by Roland Siegwart, Illah R Nourbakhsh, MIT Press, 2004 5. Rotobis: State of the art and future, Web links: 1. https://presiuniv.knimbus.com/user#/searchresult?searchId=Introduction%20to%20robotics%20and%20automation&_t=1655968277251
Topics relevant to "EMPLOYABILITY SKILLS": The sensing and digitizing function in Machine vision, Image processing and analysis, Training and Vision systems EMPLOYABILITY SKILLS through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Course Code: APT4002	Course Title: Introduction to Aptitude (Audited)	L- P- C	0	2	0
Version No.	1.0				
Course Pre-requisites	Students should know the basic Mathematics & aptitude along with understanding of English				
Anti-requisites	Nil				
Course Description	The objective of this course is to prepare the trainees to tackle the questions on various topics and various difficulty levels based on Quantitative Ability, and Logical Reasoning asked during the placement drives. There will be sufficient focus on building the fundamentals of all the topics, as well as on solving the higher order thinking questions. The focus of this course is to teach the students to not only get to the correct answers, but to get there faster than ever before, which will improve their employability factor.				

<table>
<tr><td>Course Objective</td><td colspan="4">The objective of the course is to familiarize the learners with the concepts of Aptitude and attain Skill Development through Problem Solving techniques.</td></tr>
<tr><td>Course Outcomes</td><td colspan="4">On successful completion of the course the students shall be able to:
CO1] Recall all the basic mathematical concepts they learnt in high school.
CO2] Identify the principle concept needed in a question.
CO3] Solve the quantitative and logical ability questions with the appropriate concept.
CO4] Analyze the data given in complex problems.
CO5] Rearrange the information to simplify the question</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>Quantitative Ability</td><td>Assignment</td><td>Bloom's Level : Application</td><td>12 Hours</td></tr>
<tr><td colspan="5">Topics:
Introduction to Aptitude, working of Tables, Squares, Cubes</td></tr>
<tr><td>Module 2</td><td>Logical Reasoning</td><td>Assignment</td><td>Bloom's Level : Application</td><td>18 Hours</td></tr>
<tr><td colspan="5">Topics:
Linear & Circular Arrangement Puzzle, Coding & Decoding, Blood Relations, Directions, Ordering and Ranking, Clocks and Calendars, Number Series, Wrong number series, Visual Reasoning</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5">Targeted Application & Tools that can be used:
Application area: Placement activities and Competitive examinations. Tools: LMS</td></tr>
<tr><td colspan="5">Text Book
Quantitative Aptitude by R S Aggarwal
Verbal & Non-Verbal Reasoning by R S Aggarwal</td></tr>
</table>

References www.indiabix.com www.youtube.com/c/TheAptitudeGuy/videos
Topics relevant to Skill development: Quantitative and reasoning aptitude for Skill Development through Problem solving Techniques. This is attained through assessment component mentioned in course handout.

Course Code: CIV7601	Course Title: Universal Human Values and Ethics Type of Course: MAC course	L-T-P-C	-	-	-	0
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	The purpose of the course is to develop a holistic perspective in students' life. The course adopts a self-reflective methodology of teaching and is designed to equip the students to explore their role in all aspects of living as a part of the society. It presents a universal approach to value education by developing the right understanding of reality through the process of self-exploration. This self-exploration develops more confidence and commitment in students enabling them to critically evaluate their pre-conditioning and present beliefs. As an outcome of the holistic approach, the students will be able to practice the ethical conduct in the social and professional life. The prime focus throughout the course is toward affecting a qualitative transformation in the life of the student rather than just a transfer of information. This course is designed to cater to Human Values and Professional Ethics.					
Course Objective	The objective of the course is 'SKILL DEVELOPMENT' of the student by using 'SELF LEARNING' techniques					
Course Outcomes	On successful completion of this course the students shall be able to: Recognize the importance of Value Education through the process of self-exploration Explain the human being as the co-existence of the self and the body in harmony.					

	Describe the role of foundational values in building harmonious relationships. Summarize the importance of a holistic perspective in developing ethical professional behavior.			
Course Content:				
Module 1	Introduction to Value Education	Online Assessment	MCQ Quiz	5 Sessions
Topics: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education), Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfil the Basic Human Aspirations.				
Module 2	Harmony in the Human Being	Online Assessment	MCQ Quiz	5 Sessions
Topics: Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health				
Module 3	Harmony in the Family and Society	Online Assessment	MCQ Quiz	5 Sessions
Topics: Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order.				
Module 4	Implications of the Holistic Understanding – A Look at Professional Ethics	Online Assessment	MCQ Quiz	5 Sessions
Topics: Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Holistic Technologies, Strategies for Transition towards Value-based Life and Profession				

Targeted Application & Tools that can be used: Application areas are Personal life, Education and Career, Workplace , Society and Environmental Responsibility Tools: Online Tools – NPTEL and Swayam.
Project work/Assignment:
Assessment Type Online exams (MCQs) will be conducted by the Department of Civil Engineering through Linways.
Online Link*: UHV II - https://www.youtube.com/watch?v=NhFBzn5qKIM&list=PLWDeKF97v9SO8vvjC1KyqteziTbTjN1So&pp=0gcJCWMEOCosWNin Lecture by Dr. Kumar Sambhav, NPTEL course: Universal Human Values, https://onlinecourses.swayam2.ac.in/aic22_ge23/preview Lecture by Dr. Padmavati, Dr Narendran Thiruthy, NPTEL Course: Biodiversity Protection, Farmers and Breeders Rights, https://nptel.ac.in/courses/129105008, 2024. * Other source links are available in below Resources link. Text Book A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1 Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2019. Premvir Kapoor, Professional Ethics and Human Values, Khanna Book Publishing, New Delhi, 2022.
Reference Books E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome’s report, Universe Books. A Nagraj, 1998, Jeevan Vidya Ek Parichay, Divya Path Sansthan, Amarkantak. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.

A N Tripathy, 2003, Human Values, New Age International Publishers. E G Seebauer& Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers, Oxford University Press M Govindrajran, S Natrajan& V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books. William P. Cunningham and Mary Ann Cunningham (2020), Principles of Environmental Science: Inquiry & Applications, 9th Edition, McGraw-Hill Education, USA. Resources: https://onlinecourses.swayam2.ac.in/imb25_mg195/preview https://onlinecourses.nptel.ac.in/noc25_mg141/preview https://onlinecourses.swayam2.ac.in/ini25_hs52/preview https://onlinecourses.nptel.ac.in/noc25_hs219/preview https://onlinecourses.swayam2.ac.in/cec25_mg14/preview https://onlinecourses.swayam2.ac.in/imb25_mg195/preview https://onlinecourses.swayam2.ac.in/imb25_mg196/preview
Topics relevant to Skill Development: An attitude of enquiry. Write reports The topics related to Human values and Professional ethics: All topics in are relevant to Human values and Professional ethics.

Course Code: MAT2404	Course Title: Discrete Mathematics Type of Course:1] School Core		L-T- P- C	3	1	0	4
Version No.		1.0					
Course Pre-requisites		MAT2303					
Anti-requisites		NIL					

Course Description		The course explores the study of mathematical structures that are fundamentally discrete (not continuous), focusing on concepts like set theory, logic, graph theory, combinatorics, and number theory, with applications primarily in computer science fields like algorithms, software development, and cryptography; it covers topics such as propositional logic, proof techniques, relations, functions, counting principles, and basic graph algorithms, providing a foundation for analyzing discrete problems and structures within computer science.		
Course Objective		The main objective of the course is that students should learn a particular set of mathematical facts and how to apply them. It teaches students how to think logically and mathematically through five important themes: mathematical reasoning, combinatorial analysis, discrete structures, algorithmic thinking, and applications and modeling. A successful discrete mathematics course should carefully blend and balance all five themes.		
Course Outcomes		On successful completion of the course the students shall be able to: CO1 - Explain logical sentences through predicates, quantifiers and logical connectives. CO2 - Deploy the counting techniques to tackle combinatorial problems CO3 - Comprehend the basic principles of set theory and different types of relations. CO4 - Apply different types of structures of trees for developing programming skills		
Course Content:				
Module 1	Fundamentals of Logic			(10 Classes)
Basic Connectives and Truth Tables, Propositional Logic, Applications of Propositional Logic, Propositional Equivalences, Predicates and Quantifiers, Nested Quantifiers, Rules of Inference, Introduction to Proofs, Proof Methods and Strategy.				
Module 2	Principle of Counting		Assignment	(15 Classes)
The Well Ordering Principle – Mathematical Induction The Basics of Counting, Permutations and Combinations, Binomial Coefficients and Identities, Generalized Permutations and Combinations, Generating Permutations and Combinations Advanced Principle Counting: The Principle of Inclusion and Exclusion, Generalizations of the Principle, Derangements – Nothing is in its Right Place, Rook Polynomials.				

Module 3	Relations and Functions		(10 Classes)
Cartesian Products and Relations, Functions, One-to-One, Onto Functions. The Pigeon-hole Principle, Function Composition and Inverse Functions. Relations, Properties of Relations, Computer Recognition – Zero-One Matrices and Directed Graphs, Partial Orders, Lattice, Hasse Diagrams, Equivalence Relations and Partitions.			
Module 4	Recurrence Relations and Generating Functions		(10 Classes)
Homogeneous and inhomogeneous recurrences and their solutions - solving recurrences using generating functions - Repertoire method - Perturbation method - Convolutions - simple manipulations and tricks.			
Module 5	Graph Theory & Algorithms on Networks	Assignment	(15 Classes)
Definitions and basic results - Representation of a graph by a matrix and adjacency list - Trees - Cycles - Properties - Paths and connectedness - Sub graphs - Graph Isomorphism - Operations on graphs - Vertex and edge cuts - Vertex and edge connectivity, Euler and Hamilton Paths, Shortest-Paths. Tree - Definitions, Properties, and Examples, Routed Trees, Binary search tree, Decision tree, spanning tree: BFS, DFS. Algorithms on Networks - Shortest path algorithm- Dijikstra's algorithm, Minimal spanning tree- Kruskal algorithm and Prim's algorithm.			
Targeted Application & Tools that can be used: Discrete mathematics provides the mathematical foundations for many computer science courses including data structures, algorithms, database theory, automata theory, formal languages, compiler theory, computer security, and operating systems.			
Assignment:			
Assignment 1: Logic Equivalences and Predicate calculus. Assignment 2: Equivalence Relations and Lattices Assignment 3: Recurrence Relations			
Text Book Kenneth H. Rosen, "Discrete Mathematics and its Applications", McGraw-Hill,s 8th Edition,2019. Harary – Graph Theory, Addison-Wesley Publishing Company.			
References: Arthur Gill, "Applied Algebra for Computer Science", Prentice Hall.			

K.D. Joshi, "Discrete Mathematics", Wiley Eastern Ltd. Ralph. P. Grimaldi., "Discrete and Combinatorial Mathematics: An Applied Introduction", 4th Edition, Pearson Education Asia. E-resources/ Web links: https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_54588 https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_375 https://www.math.hkust.edu.hk/~maqian/ma006_0607F.html https://www.scu.edu.au/study-at-scu/units/math1005/2022/
Topics relevant to SKILL DEVELOPMENT: The course focuses on the concepts of calculus and differential equation with reference to specific engineering problems. The course is of both conceptual and analytical type in nature through Problem solving. This is attained through the assessment component mentioned in course handout.

<table>
<tr><td>Course Code:

CAI2500</td><td>Course Title: Machine Learning

Type of Course: 1] Program Core
2] Theory</td><td>L-T-P-C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="6">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="6">MAT2303</td></tr>
<tr><td>Anti-requisites</td><td colspan="6">NIL</td></tr>
<tr><td>Course Description</td><td colspan="6">Machine Learning algorithms are the key to develop intelligent systems such as Apple’s Siri, Google’s self-driving cars etc. This course introduces the concepts of the core machine learning techniques such as Regression learning, Bayesian learning, Ensemble learning, Perceptron learning, Unsupervised learning, Competitive learning, learning from Gaussian mixture models and learning to detect outliers. Course lectures cover both the theoretical foundations as well as the essential algorithms for the various learning methods. Lectures enable the students to develop intelligent systems for real life problems.</td></tr>
<tr><td>Course Objectives</td><td colspan="6">This course is designed to improve the learners ‘EMPLOYABILITY SKILLS’ by using EXPERIENTIAL LEARNING techniques.</td></tr>
<tr><td>Course Out Comes</td><td colspan="6">On successful completion of the course the students shall be able to:

CO1: Apply advanced supervised machine learning methods for predictive modeling. [Apply]

CO2: Employ advanced unsupervised learning algorithms for clustering, competitive learning and outlier detection [Apply]

CO3: Build machine learning models with better predictive performance using Ensemble learning algorithms [Apply]

CO4: Build predictive models using Perceptron learning algorithms [Apply]</td></tr>
<tr><td>Course Content:</td><td colspan="6"></td></tr>
</table>

<table>
<tr><td>Module 1</td><td>Supervised Learning</td><td>Participative Learning</td><td>Brainstorming session/Quiz</td><td>No. of Sessions
L – 10</td></tr>
<tr><td colspan="5">Topics: An overview of Machine Learning(ML); ML workflow; types of ML; Types of features, Feature Engineering -Data Imputation Methods; Regression – introduction; simple linear regression, loss functions; Polynomial Regression; Logistic Regression; Softmax Regression with cross entropy as cost function; Bayesian Learning – Bayes Theorem, estimating conditional probabilities for categorical and continuous features, Naïve Bayes for supervised learning; Bayesian Belief networks; Support Vector Machines – soft margin and kernel tricks.</td></tr>
<tr><td>Module 2</td><td>Unsupervised Learning</td><td>Participative Learning</td><td>Brainstorming session/Quiz</td><td>No. of Sessions
L-8</td></tr>
<tr><td colspan="5">Topics: Unsupervised Learning – k Means clustering- simple and mini-batch; updating centroids incrementally; finding the optimal number of clusters using Elbow method ; Silhouette coefficient, drawbacks of kMeans, kMeans++ ; Divisive hierarchical clustering – bisecting k-means, clustering using Minimum Spanning Tree (MST), Density Based Spatial Clustering – DBSCAN; Outlier Detection methods – Isolation Forest, Local Outlier Factor(LOF)</td></tr>
<tr><td>Module 3</td><td>Ensemble Learning</td><td>Participative Learning</td><td>Brainstorming session/Quiz</td><td>No. of Sessions
L-6</td></tr>
<tr><td colspan="5">Topics: Ensemble Learning – using subset of instances – Bagging, Pasting, using subset of features –random patches and random subspaces method; Voting Classifier, Random Forest; Boosting – AdaBoost, Gradient Boosting, Stacking.</td></tr>
<tr><td>Module 4</td><td>Perceptron Learning</td><td>Participative Learning</td><td>Brainstorming session/Quiz</td><td>No. of Sessions
L-6</td></tr>
<tr><td colspan="5">Topics: Perceptron Learning – from biological to artificial neurons, Perceptron, Linear Threshold Units, logical computations with Perceptron, common activation functions – sigmoid, tanh, relu and SoftMax, common loss functions, multi-layer Perceptron and the Backpropagation algorithm using Gradient Descent.</td></tr>
<tr><td colspan="5">Targeted Application & Tools that can be used:</td></tr>
</table>

Students can be assigned a mini project to develop a machine learning application for real-life problems in various domains such as health care, business intelligence, environmental modeling, etc.
Project work/Assignment: Certification course in Machine Learning through NPTEL Mini Project on (Module 1 to Module 4)
Textbooks Aurélien Géron, “Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow”, Oreilly, Second Edition, 2019. Andreas C Muller, Sarah Guido, “Introduction to Machine Learning with Python: A Guide for Data Scientists”, Oreilly, First Edition, 2018
References Giuseppe Bonaccorso, “Machine Learning Algorithms: A reference guide to popular algorithms from data science and machine learning”, Packt Publishing, 2017

Course Code: CAI2501	Course Title: Machine Learning Lab Type of Course: 1] Program Core 2] Laboratory	0	0	4	2
Version No.	1.0				
Course Pre-requisites	CSE1500				
Anti-requisites	NIL				

Course Description	Machine Learning algorithms are the key to develop intelligent systems such as Apple's Siri, Google's self-driving cars etc. This course introduces the concepts of the core machine learning techniques such as Regression learning, Bayesian learning, Ensemble learning, Perceptron learning, Unsupervised learning, Competitive learning, learning from Gaussian mixture models and learning to detect outliers. Course lectures cover both the theoretical foundations as well as the essential algorithms for the various learning methods. Lab sessions complement the lectures and enable the students to develop intelligent systems for real life problems.
Course Objectives	This course is designed to improve the learners 'EMPLOYABILITY SKILLS' by using EXPERIENTIAL LEARNING techniques.
Course Out Comes	On successful completion of the course the students shall be able to: CO1: Apply advanced supervised machine learning methods for predictive modeling. [Apply] CO2: Employ advanced unsupervised learning algorithms for clustering, competitive learning and outlier detection [Apply] CO3: Build machine learning models with better predictive performance using Ensemble learning algorithms [Apply] CO4: Build predictive models using Perceptron learning algorithms [Apply]

List of Laboratory Tasks:

Experiment N0 1: Methods for handling missing values

Level 1: Given a data set from UCI repository, implement the different ways of handling missing values in it using Scikit-learn library of Python

Level 2: Implement one of these methods using a custom defined function in Python.

Experiment No. 2: Data Visualization

Level 1 : Perform Exploratory Data Analysis for a given data set by creating Scatter Plot, Pair Plot, Count Plot using Matplotlib and Seaborn

Level 2: Create Heat Maps, Word Cloud

Experiment No. 3: Regression learning

Level 1: Given a data set from UCI repository, implement the simple linear regression algorithm and estimate the model's parameters and the performance metrics. Plot the learning curves.

Level 2: Implement the polynomial regression algorithm. Compare the learning curves of Polynomial and Linear Regression.

Experiment No.4: Logistic regression

Level 1: Write custom code for generating the logistic/sigmoid plot for a given input

Level 2 : Given a data set from UCI repository, implement the Logistic regression algorithm. Estimate the class probabilities for a given test data set. Plot and analyze the decision boundaries.

Experiment No.5: Bayesian Learning

Level 1: Given a data set from UCI repository, implement a classification model using the Bayesian algorithm

Experiment No.6: Support Vector Machine (SVM)

Level 1: Given data sets from UCI repository, implement a linear SVM based classification model.

Level 2: Given data sets from UCI repository, implement a non-linear SVM based classification model.

Experiment No. 7: Unsupervised Learning

Level 1: K–means – simple and mini-batch. Finding the optimal number of clusters using Elbow method and Silhouette Coefficient. Compare the inertia of both as k increases. Tuning the hyperparameter 'k' using GridSearchCV.

Level 2: Using clustering for Image segmentation and Preprocessing. Kmeans++

Experiment No. 8: Density Based Clustering Level 1: Implement DBSCAN – clustering using the local density estimation. Level 2: Perform hard and soft clustering for new instances. Experiment No. 9: Ensemble Learning using Subset of Instances Level 1: Implement Ensemble Learning algorithms such as Bagging, Pasting and Out-of Bag Evaluation Level 2: Random Patches and Random Subspace Method Experiment No. 10: Ensemble Learning using Subset of Features Level 1: Apply ensemble learning techniques such as AdaBoost and Gradient Boosting Level 2: Apply ensemble learning techniques such as Stacking Experiment No. 11: Perceptron Learning Level 1: Implement the Perceptron Classifier Level 2: – An Image Classifier Using the Sequential API of Keras Experiment No. 12: Outlier Detection Level 1 Outlier Detection using Isolation Forest Level 2: Outlier Detection using Local Outlier Factor
Targeted Application & Tools that can be used: Execution of the ML algorithms will be done using the Google's cloud service namely "Colab", available at https://colab.research.google.com/ or Jupyter Notebook. The data sets will be from the bench marking repositories such as UCI machine learning repository available at: https://archive.ics.uci.edu/ml/index.php Laboratory tasks will be implemented using the libraries available in Python such as Scikit learn, matplotlib, seaborn, perceptron and the deep learning framework namely Keras.

Project work/Assignment:
Students can be assigned a mini project to develop a machine learning application for real-life problems in various domains such as health care, business intelligence, environmental modeling, etc.
Textbook s Aurélien Géron, "Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow", Oreilly, Second Edition, 2019. Andreas C Muller, Sarah Guido, "Introduction to Machine Learning with Python :A Guide for Data Scientists", Oreilly, First Edition, 2018 Giuseppe Bonaccorso, "Machine Learning Algorithms: A reference guide to popular algorithms from data science and machine learning", Packt Publishing, 2017.
References Giuseppe Bonaccorso, "Machine Learning Algorithms: A reference guide to popular algorithms from data science and machine learning", Packt Publishing, 2017

Course Code: CSE2502/ CAI2502	Course Title: Deep Learning Type of Course: Theory	L- T- P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	CSE1500					
Anti-requisites	NIL					

Course Description	This course introduces students to the concepts of deep neural networks and state of the art approaches to develop deep learning models. In this course students will be given exposure to the details of neural networks as well as deep learning architectures and to develop end-to-end models for such tasks. It will help to design and develop application-specific deep learning models and provide practical knowledge handling and analyzing end user realistic applications. Topics include Fundamental concepts of deep neural networks, Convolutional Neural Networks, Recurrent Network structures, Deep Unsupervised Learning, Generative Adversarial Networks and applications in various problem domains.			
Course Outcomes	On successful completion of this course the students shall be able to: CO1: Learn the Fundamental Principles of Deep Learning. (Remember). CO2: Identify the Deep Learning Algorithms for Various Types of Learning Tasks in various domains (Apply). CO3: Build Supervised and Unsupervised Deep Learning techniques to implement effective models for prediction or classification tasks. (Apply). CO4: Make use of appropriate validation metrics to evaluate the performance of Implemented Deep Neural Network. (Apply)			
Course Content:				
Module 1	Introduction to Deep Learning and Neural Networks	Assignment		8 Classes
Topics: Fundamentals of Deep Learning, Perceptron, Multilayer Perceptron, Optimizing Perceptions using Activation Functions, Loss Functions, Gradient Descent.Feedforward Neural Network, Training Neural Network with Back-propagation, Hyper parameters, Regularization, Dropouts, Batch Normalization, Practical Issues in Neural Network Training -The Problem of Overfitting, The Vanishing and Exploding Gradient Problems				
Module 2	Common Deep Learning Architectures:	Assignment		8 Classes

<table>
<tr><td colspan="5">Topics:

Convolutional Neural Network, Transfer learning Techniques, Variants of CNN: ResNet, AlexNet

Sequence Modelling: Recurrent Neural Network and its variants - Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU)</td></tr>
<tr><td>Module 3</td><td>Deep Generative Models</td><td>Assignment</td><td></td><td>7
Classes</td></tr>
<tr><td colspan="5">Topics:

Generative Adversarial Networks, Kohonen Networks, Autoencoders, Boltzman Machine, Restricted Boltzmann Machine, Deep Belief Network</td></tr>
<tr><td>Module-4</td><td>Advanced Deep Learning Architectures</td><td>Assignment</td><td></td><td>7
Classes</td></tr>
<tr><td colspan="5">Topics:

Hopfield Network, Probabilistic Neural Network, Deep Reinforcement Learning - The Basic Framework of Reinforcement Learning

Deep Learning applications: Image segmentation, Object detection, Attention model for computer vision tasks, Speech Recognition, Video Analytics</td></tr>
<tr><td colspan="5">Project work/Assignment:</td></tr>
<tr><td colspan="5">Assignment 1 on (Module 1 and Module 2)

Assignment 2 on (Module 3 and Module 4)</td></tr>
<tr><td colspan="5">REFERENCE MATERIALS:

TEXTBOOKS

François Chollet, “Deep Learning with Python”, 2nd Edition, Manning Publications, 2022

Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2017.

REFERENCES</td></tr>
</table>

Amlan Chakrabarti Amit Kumar Das, Saptarsi Goswami, Pabitra Mitra, "Deep Learning", Pearson Publication, 2021.

David Foster, "Generative Deep Learning" O'Reilly Publishers, 2020.

John D Kellehar, "Deep Learning", MIT Press, 2020.

JOURNALS/MAGAZINES

IEEE Transactions on Neural Networks and Learning Systems

https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=5962385

IEEE Transactions on Pattern Analysis and Machine Intelligence

https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=34http://ijaerd.com/papers/special_papers/IT032.pdf

International Journal of Intelligent Systems https://onlinelibrary.wiley.com/journal/1098111x

SWAYAM/NPTEL/MOOCs:

Swayam Nptel – Deep Learning – IIT Ropar
https://onlinecourses.nptel.ac.in/noc21_cs35/preview

Coursera – Neural Networks and Deep Learning Andrew Ng

Coursera - Neural Networks for Machine Learning by Geoffrey Hinton in Coursera

Course Code: CAI2503	Course Title: Deep Learning Lab Type of Course: LABORATORY	L- T- P- C	0	0	4	2
Version No.	1.0					
Course Pre-requisites	CSE1500					
Anti-requisites	NIL					
Course Description	This course introduces students to the concepts of deep neural networks and state of the art approaches to develop deep learning models. In this course students will be given exposure to the details of neural networks as well as deep learning architectures and to develop end-to-end models for such tasks. It will help to design and develop application-specific deep learning models and provide practical knowledge handling and analyzing end user realistic applications. Topics include Fundamental concepts of deep neural networks, Convolutional Neural Networks, Recurrent Network structures, Deep Unsupervised Learning, Generative Adversarial Networks and applications in various problem domains.					
Course Outcomes	On successful completion of this course the students shall be able to: CO1: Learn the Fundamental Principles of Deep Learning. (Remember). CO2: Identify the Deep Learning Algorithms for Various Types of Learning Tasks in various domains (Apply). CO3: Build Supervised and Unsupervised Deep Learning techniques to implement effective models for prediction or classification tasks. (Apply). CO4: Make use of appropriate validation metrics to evaluate the performance of Implemented Deep Neural Network. (Apply)					
Course Content:						
List of Laboratory Tasks: Experiment No. 1: Working with Deep Learning Framework Level 1: Explore various Deep Learning Frameworks and identify deep learning frameworks (Keras, Tensorflow, Matplotlib, etc) with various methods available in DL Frameworks to develop a Model. Experiment No. 2: Build a Basic Artificial Neural Network						

Level 1: Create an ANN with DL frameworks and identify suitable ANN Layers using Keras and Tensorflow for pima-indians-diabetes.

Level 2: Create an ANN with DL frameworks and identify suitable ANN Layers using Keras and Tensorflow for any image dataset.

Experiment No. 3: Build a Multi-Layer Perceptron

Level 1: Create a MLP for classification task by identify suitable model for house price prediction.

Level 2: Design a MLP for implementing classification and fine-tuning for speech recognition

Experiment No. 4: Build a Convolutional Neural Network

Level 1: Build CNN architecture for Dog-Cat classification problem.

Level 2: Build Convolution Neural Network (CNN) for fine tuning hyperparameter for improving the performance of model.

Experiment No. 5: Build ResNet Model

Level 1: Build ResNet Model for Medical Imaging Datasets ChestX-ray14

Level 2: Build ResNet Model for Video datasets

Experiment No. 6: Build AlexNet Model

Level 1: Build ResNet Model for CIFAR10 Datasets.

Level 2: Build ResNet Model for Video datasets

Experiment No. 7: Build a Time-Series Model

Level 1: Build RNN/LSTM Model for predicting time series data for sentiment analysis model on IMDB dataset.

Experiment No. 8: Build a Time-Series Model

Level 1: Build RNN/GRU Model for predicting time series data for sentiment analysis model on IMDB dataset.

Experiment No. 9: Build GANs for CIFAR10

Level 1: Develop a GAN to Generate CIFAR10 Small Color Photographs

Experiment No. 10: Build a Transfer Learning Model.

Level 1: Create a Seq2Seq Model. Create Hugging-face API using Transfer learning model.

Experiment No. 11: Build an Auto-Encoder model

Level 1: Implement an Encoder-Decoder Recurrent neural network model for Neural Machine Translation.

Experiment No. 12: Build Generative Adversarial Networks. Level 1: Design GAN Architecture for Image generations. Level 2: Design a Age Prediction model by Applying Generative Adversarial
REFERENCE MATERIALS: TEXTBOOKS François Chollet, “Deep Learning with Python”, 2nd Edition, Manning Publications, 2022 Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2017. REFERENCES Amlan Chakrabarti Amit Kumar Das, Saptarsi Goswami, Pabitra Mitra , “Deep Learning”, Pearson Publication, 2021. David Foster, “Generative Deep Learning” O’Reilly Publishers, 2020. John D Kellehar, “Deep Learning”, MIT Press, 2020. JOURNALS/MAGAZINES IEEE Transactions on Neural Networks and Learning Systems https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=5962385 IEEE Transactions on Pattern Analysis and Machine Intelligence https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=34http://ijaerd.com/papers/special_papers/IT032.pdf International Journal of Intelligent Systems https://onlinelibrary.wiley.com/journal/1098111x SWAYAM/NPTEL/MOOCs: Swayam Nptel – Deep Learning – IIT Ropar https://onlinecourses.nptel.ac.in/noc21_cs35/preview Coursera – Neural Networks and Deep Learning Andrew Ng Coursera - Neural Networks for Machine Learning by Geoffrey Hinton in Coursera

Course Code: RAI2004	Course Title: IoT and Automation Type of Course: Theory Only	L- T-P- C	2	0	0	2
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	This course provides a comprehensive introduction to the principles and technologies underpinning modern automation and robotic systems in industrial environments. It is structured to equip students with theoretical knowledge and practical skills in automated manufacturing, control systems, industrial robotics, and Industry 4.0 concepts.					
Course Objective	To provide an introduction to Industry 4.0 its applications in industry. To provide the student with basic skills useful in identifying the concepts of automation using hydraulics, pneumatic and PLC. To impart knowledge on robot kinematics and programming for a given application.					
Course Outcomes	On successful completion of the course the students shall be able to: CO1: design pneumatic and hydraulic circuits CO2: program PLC for a given application CO3: choose appropriate materials handling devices and perform robot programming for a given application					

	CO4: solve direct and inverse kinematics and choose appropriate Robot for given application CO5: apply IOT to different applications			
Course Content:				
Module 1	Industry 4.0 & IoT	Assignment		10 sessions
Topics: Industry 4.0 & IoT: Introduction. Digitization, Drivers of Industry 4.0, End-to-end digital integration within a smart factory, IOT Swarm Sensors, RF and wireless sensors module, power management module; Challenges. Internet of Things (IoT): Introduction, Physical system, Cyber-Physical Systems, IoT Architectures. Applications: Smart cities & smart homes, connected vehicles, Healthcare, Machine condition monitoring, Process monitoring and control.				
Module 2	Introduction to Automation	Assignment		10 Sessions
Topics: Introduction to Automation – Automated manufacturing systems. Sensors and Actuators in Automation – Digital and analog sensors; Fluid power actuators; Control valves; Electrical system elements; Motors drives; Mechanical devices. Pneumatic and Hydraulic Systems – Pneumatic fundamentals – control elements, position and pressure sensing – logic circuits – switching circuits – sequential circuits – cascade method. Control Using PLCs – Relay logic; Combinational and sequential control, Sequential flow chart, Minimization of logic equations; Ladder logic diagrams; Programmable logic controllers (PLCs); PLC components; Programming; I/O addresses; Timer and counters; A/D conversion and sampling; PLC applications. Introduction to SCADA				
Module 3	Detroit Automation	Assignment		10 Sessions
Topics: Detroit Automation, Material Handling –Mechanization devices and material handling systems; Mechanization of parts handling; Parts feeding; Parts sensing; Automated Guided Vehicle. Industrial Robotics -Robot anatomy – Work volume – Drive systems – Sensors in robotics – Robot reference frames and coordinates and robot kinematics. End effectors: Mechanical and other types of grippers – Tools as end effectors – Robot end effectors interface. Robot kinematics. Typical applications of robots: material transfer, machine loading/unloading; processing operations; assembly and inspection.				
Text Book(s):				

Robert J. Schilling, "Fundamentals of Robotics, Analysis & Control", Prentice Hall, 2009. Antony Espossito, "Fluid power with Applications ", Pearson, Sixth Edition., 2003. Raj, Pethuru, and Anupama C. Raman.The Internet of things: Enabling technologies, platforms, and use cases. Auerbach Publications, 2017.
Reference(s): Mikell P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Third Edition, Pearson Education, 2009. Nanua Singh, Tatla Dar Singh., "Systems Approach to Computer-Integrated Design and Manufacturing", John Wiley & Sons, 1995. Bahga, Arshdeep, and Vijay Madisetti.Internet of Things: A hands-on approach. Vpt, 2014. Buyya, Rajkumar, and Amir VahidDastjerdi, eds. Internet of Things: Principles and paradigms. Elsevier, 2016.

Course Code: RAI2005	Course Title: IoT and Automation Lab Type of Course: Lab Only	L- T-P- C	0	0	2	1
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	This course provides a comprehensive introduction to the principles and technologies underpinning modern automation and robotic systems in industrial environments. It is structured to equip students with theoretical knowledge and practical skills in automated manufacturing, control systems, industrial robotics, and Industry 4.0 concepts.					
Course Objective	To provide an introduction to Industry 4.0 its applications in industry. To provide the student with basic skills useful in identifying the concepts of automation using hydraulics, pneumatic and PLC. To impart knowledge on robot kinematics and programming for a given application.					

Course Outcomes	On successful completion of the course the students shall be able to: CO1: design pneumatic and hydraulic circuits CO2: program PLC for a given application CO3: choose appropriate materials handling devices and perform robot programming for a given application CO4: solve direct and inverse kinematics and choose appropriate Robot for given application CO5: apply IOT to different applications
Course Content:	
Experiments:	
Implementation of IoT for Temperature dependent cooling system, Engine management system, Machine condition monitoring Health care monitoring Logical Circuits – Pneumatic and Electro-Pneumatic Circuits Study of PLC and PLC based ElectroPneumatic Sequencing Circuits. Visual Inspection of Objects by Computer Vision Technology. Robot Programming using Teach Pendent Offline Programming to Perform Pick and Place, Stacking of Objects.	
Text Book(s): Robert J. Schilling, “Fundamentals of Robotics, Analysis & Control”, Prentice Hall, 2009. Antony Espossito, “Fluid power with Applications “, Pearson, Sixth Edition., 2003. Raj, Pethuru, and Anupama C. Raman.The Internet of things: Enabling technologies, platforms, and use cases. Auerbach Publications, 2017.	

Reference(s):

Mikell P. Groover, “Automation, Production Systems and Computer Integrated Manufacturing”, Third Edition, Pearson Education, 2009.

Nanua Singh, Tatla Dar Singh., “Systems Approach to Computer-Integrated Design and Manufacturing”, John Wiley & Sons, 1995.

Bahga, Arshdeep, and Vijay Madisetti.Internet of Things: A hands-on approach. Vpt, 2014.

Buyya, Rajkumar, and Amir VahidDastjerdi, eds. Internet of Things: Principles and paradigms. Elsevier, 2016.

Course Code: EEE2509	Course Title: Control Systems for Robotics Type of Course: Program core and Theory only	L-T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	EEE1250					
Anti-requisites	NIL					
Course Description	This course provides a comprehensive introduction to control system theory and its application in robotic systems. Students will learn how to model, analyze, and design control systems that allow robots to operate autonomously, interact with dynamic environments, and perform complex tasks with precision. The course is both conceptual and analytical in nature and needs fair knowledge of Mathematical and computing. The course develops the critical thinking and analytical skills. The course also enhances the programming and simulation abilities through assignments					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Control Systems for Robotics and attain Skill Development through Problem Solving methodologies					
Course Out Comes	On successful completion of the course the students shall be able to: 1] Explain the various signals and systems used in control system 2] Summarize the time domain specifications for various test input signals and effect of poles and zeros on time response					

	3] Apply different stability analysis techniques in time domain and frequency domain to know the nature of stability of the system. 4] Discuss about the controllability and observability of the given state model			
Course Content:				
Module 1	Signals and System	Assignment		10 Sessions
Topics: Introduction to Signals and System, Basic signals: Unit step, unit impulse, exponential, sinusoidal, Signal Classifications, Properties of systems Introduction to control systems, Role of control in robotics, Transfer functions, mathematical Modeling of mechanical, electrical, and electromechanical systems-Robotic arms. Block diagrams and Signal flow graph.				
Module 2	Time Response Analysis	Assignment, Quiz	Programming / Simulation	10 Sessions
Topics: Unit step response of first and second order system, time response specifications, time response specifications of second order systems, steady state errors and error constants. Poles and zeros and their effects on time response.				
Module 3	Stability Analysis	Simulation	Programming	15 Sessions
Topics: Concept of stability, Routh stability criterion, Root locus concept-rules for sketching root locus, Introduction, Frequency domain specifications -Bode diagrams, Stability Analysis from Bode Plots, Concept of relative stability. Introduction to Nyquist stability criteria, P, PI, PD and PID controllers, Lead, Lag, lead-lag compensating networks				
Module 4	State space model	Case study	Simulation	10 Sessions
Topics: Concept of State, State variables & State model, Controllability and observability. Introduction to non linear systems Stability of Nonlinear Systems - Lyapunov stability, state feedback control - stabilization - tracking				
Targeted Application & Tools that can be used:				

Control Systems are used in domestic applications, traffic light control, general industry, military and virtually every modern vehicle in the world, robotics. Modern industrial plants utilized robots for manufacturing temperature controls, pressure controls, speed controls, position controls, etc. In chemical process, control field is an area where automations play an important role.

Professionally used tools: MATLAB/Simulink, Scilab, Octave.

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

Assignment:

Modeling of a second order system: Construct a Simulink diagram to calculate the response of the Mass-Spring system. The input force increases from 0 to 8 N at t = 1 s. The parameter values are M = 2 kg, K= 16 N/m, and B =4 N.s/m.

Using an m-file script, determine the close-loop transfer function of a given control system.

Identifying the system stability using Root locus technique by executing a programming code.

Open loop and closed loop time response of a second order system with different test inputs in MATLAB.

Using an m-file script, analyze the Frequency response of a system using Bode plot.

Implementation of controller (P/PI/PID) using aurdino.

Text Book

[1]. Nagrath I. J. and M. Gopal, Control Systems Engineering, New Age International (P) Ltd, 5th ed, 2007.

[2]. K. Ogata, 'Modern Control Engineering', Pearson Education Asia / PHI, 4th Edition.

References

[1] Benjamin Kuo, 'Automatic Control Systems', PHI, 7th Edition.

[2] Hasan Saeed, automatic control Systems with MATLAB programs, S K Kataria and sons, Latest ed.

Online Learning Resources:

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

Case study: https://people.disim.univaq.it/~costanzo.manes/Didattica_Teoria_dei_Sistemi/System_Theory_Web_Resources.html

https://nptel.ac.in/courses/107/106/107106081/

Topics relevant to “SKILL DEVELOPMENT”: Mathematical modelling, Stability analysis, Compensators Skill Development through Problem Solving methodologies. This is attained through assessment component mentioned in course handout.

Course Code: EEE2566	Course Title: Control Systems for Robotics Lab Type of Course: Program core and Lab	L- T-P-C	0	0	2	1
Version No.	1.0					
Course Pre-requisites	EEE1200: Basics of Electrical and Electronics Engineering.					
Anti-requisites	Nil					
Course Description	The purpose of this course is to provide an opportunity to validate the concepts taught in the course control system for robotics and enhances the ability to visualize the real system performance by conducting the experiments through hardware and software The course develops critical thinking and analytical skills of the student. The course also enhances the student’s programming and simulation abilities					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Control Systems Engineering Laboratory experiments and attain Skill Development through Experiential Learning techniques.					
Basic skill sets required for the laboratory:						
	The students shall be able to develop: An attitude of enquiry. Confidence and ability to tackle new problems.					

	Ability to interpret events and results. Ability to work as a leader and as a member of team. Assess errors and eliminate them. Observe and measure physical phenomenon. Write Reports. Select suitable equipment, instrument and materials. Locate faults in systems. Manipulative skills for setting and handling equipment. The ability to follow standard test procedures. An awareness of the need to observe safety precautions. To judge magnitudes without actual measurement.
Course Out Comes	On successful completion of the course the students shall be able to: Summarize the time domain specifications for second order system. Explain the behaviour of lag, lead and lag - lead compensating networks Analyze the performance of P, PI, and PID controllers. Analyze the stability of LTI system using Root locus and Bode plots
Course Content:	
List of Laboratory Tasks: Experiment No. 1: Time Response of Second Order System representing the robotic system Level 1: To determine the time response characteristics of a second order system to a step input when the system is underdamped, over damped and critically damped and evaluation of time response specifications. Level 2: To comment on the effect of additional poles and zeros on time response of second order system in MATLAB	

Experiment No. 2: Effect of P, PI and PID on a Second Order System of robotic arm using MATLAB

Level 1: To study the steady state performance of an analog P, PI & PID controller using PID controller kit.

Level 2: To simulate the effect of P, PI, PD and PID Controllers on a given second order system for a unit step input by developing a MATLAB Code.

Experiment No. 3: Characteristics of AC Servo Motor used for robotic applications.

Level 1: To study the Speed-Torque and Speed-Back e.m.f. characteristics of AC Servomotor.

Experiment No. 4: Stability Analysis (Bode, Root Locus) of LTI System using MATLAB.

Level 1: To analyze frequency response of a system by plotting Root locus, bode plot using

MATLAB software.

Experiment No. 5: DC Position control System using MATLAB

Level 1: To simulate a DC position control system using MATLAB and obtain its step response.

Experiment No. 6 : RC Lead Compensating Network.

Level 1: To implement a passive RC lead compensating network for the given specifications and to obtain its frequency response.

Level 2: To implement a passive RC lead compensating network for the given specifications and to obtain its frequency response using MATLAB software.

Experiment No. 7: RC Lag Compensation Network.

Level 1: To project a passive RC lag compensating network for the given specifications and to obtain its frequency response.

Level 2: To implement a passive RC lag compensating network for the given specifications and to obtain its frequency response using MATLAB software.

Experiment No. 8: RC Lag-Lead Compensation. Level 1: To study the Frequency Response of a given Lead-Lag Compensating Network. Level 2: To study the Frequency Response of a given Lead-Lag Compensating Network using MATLAB software.
Targeted Application & Tools that can be used: Control Systems are used in domestic applications, traffic light control, general industry, military and virtually every modern vehicle in the world, robotics. Modern industrial plants utilized robots for manufacturing temperature controls, pressure controls, speed controls, position controls, etc. In chemical process, control field is an area where automations play an important role. Professionally used tools: MATLAB/Simulink, Scilab, Octave.
Course Material Control Systems Lab Manual, Presidency University, Bengaluru. Text Book: Nagrath I. J. and M. Gopal, Control Systems Engineering, New Age International (P) Ltd, 5th ed, 2007. Reference Books: K. Ogata, ‘Modern Control Engineering’, Pearson Education Asia / PHI, 4th Edition. Benjamin Kuo, ‘Automatic Control Systems’, PHI, 7th Edition. Hasan Saeed, automatic control Systems with MATLAB programs, S K Kataria and sons, Latest ed. Online Resources: https://puniversity.informaticsglobal.com Ebook: https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-01sc-introduction-to-electrical-engineering-and-computer-science-i-spring-2011/unit-2-signals-and-systems/designing-control-systems/ Case study: https://nptel.ac.in/courses/107/106/107106081/

Topics relevant to "SKILL DEVELOPMENT": Computing and performing the stability of the given system and assessing the stability by using theoretically and practically are for Skill Development through Experiential Learning techniques. This is attained through assessment component mentioned in course handout.

Course Code: CSE2264	Course Title: Essentials of AI Type of Course: Engineering Sciences Core -Theory	L-T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	CSE15000					
Anti-requisites	NIL					
Course Description	This course introduces the student to the basics of artificial intelligence. In this course, the student first learns the various search methods for problem-solving, followed by knowledge-based logic representations. After that, the student will learn about uncertainty in AI, as well as approaches to solve such challenges such as Naïve Bayes Classifier and Hidden Markov Models. Topics: Uninformed search, Heuristic search, Local search, Adversarial search, Constraint satisfaction, logic, First Order Resolution, Probability, Naïve Bayes Classifier, and Hidden Markov Model (HMM).					
Course Objectives	The objective of the course is EMPLOYBILITY of student by using EXPERIENTIAL LEARNING techniques.					
Course Out Comes	On successful completion of this course the students shall be able to: Explain different methods of searching, proving, and analysis in AI [Understand] Implement various graphical and adversarial search algorithms. [Apply] Prove, by resolution, different situations using First Order Logic [Apply] Solve sequence labeling problems using HMM [Apply]					
Course Content:						

Module 1	Search Methods for Problem-Solving	Problem-Solving Tests	NPTEL Assignments	No. of Sessions: 13
Introduction – State Space Search; General Formulation of Search Problems; Data Structures used in Searching. Uninformed Search Algorithms – Breadth First Search, Depth First Search, Uniform Cost Search, Generalized Uniform Cost Search (a.k.a Dijkstra's Single-Source Shortest Path), Iterative Deepening Depth-First Search, Time and Space Complexity Analysis of Uninformed Search Algorithms. Heuristic Search Algorithms – Heuristics and Admissibility, Greedy Best-First Search, A* Search and weighted A* Search.				
Module 2	Advanced Search Methods	Problem-Solving Tests	NPTEL Assignments	No. of Sessions: 12
Local Search – Local Search, Hill Climbing, Genetic Algorithms, Gradient Descent. Adversarial Search – Minimax Search, Alpha-Beta Pruning, Ideal Ordering. Constraint Satisfaction – Constraint Satisfaction Problems Definitions and Examples – Map Colouring, N Queens, Cryptarithmetic, Generalized CSP; Back-tracking Heuristics; Arc Consistency and Path Consistency				
Module 3	Knowledge-Based Logic Representation	Automated Theorem Proving using FOL Resolution	NPTEL Assignments	No. of Sessions: 10
Propositional Logic – Syntax and Semantics of Propositional Logic. Logical connectives. Inference Rules. Conjunctive and Disjunctive Normal Forms. First Order Logic – Syntax and Semantics of Propositional Logic. Logical connectives. Inference Rules. Conjunctive and Disjunctive Normal Forms. Resolution – Resolution Principle. Propositional and First Order Resolution. Applications for solving story problems using Resolution				
Module 4	Uncertainty in AI	Representing problems as HMM	NPTEL Assignments	No. of Sessions: 06
Probability – Probability Definitions. Conditional Probability. Bayes Theorem. Naïve Bayes Classifier. Using Naïve Bayes Classifier for Supervised Learning. Hidden Markov Models – Definition of HMM. Sequence Labeling and Markov Assumption. Sub-Problems in HMM and their solutions – Forward Probability and Viterbi Algorithm. Applications of Sequence Labeling in Natural Language Processing (Eg. Part-of-Speech Tagging). Introduction to Deep Learning – Artificial Neurons, Activation Functions, Multilayer Perceptron.				
Targeted Application & Tools that can be used: Implementation of a shortest-path finder using different search algorithms. Implementation of a sequence labeler using Viterbi Algorithm.				

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

Group project on one of the topics mentioned above (Eg. Adversarial search).

Textbook(s):

Stuart Russel and Peter Norvig. Artificial Intelligence: A Modern Approach. 4th Edition. Pearson Education. 2022.

Lavika Goel. Artificial Intelligence: Concepts and Applications. 1st Edition. Wiley. 2021.

Elaine Rich, Kevin Knight and Shivashankar B Nair. Artificial Intelligence. 4th Edition. MedTech Science Press. 2024.

References:

Deepak Khemani. A First Course in Artificial Intelligence. 1st Edition. 6th Reprint, 2018.

Munesh Chandra Trivedi. A Classical Approach to Artificial Intelligence. 2nd Edition. Khanna Publishers. 2018.

George Luger. Artificial Intelligence: Structures and Strategies for Complex Problem Solving. 6th Edition. Pearson Education. 2021.

Weblinks

NPTEL Courses: Mausam (IIT Delhi), “An Introduction to Artificial Intelligence” Link: https://nptel.ac.in/courses/106102220.

Shyamanta M. Hazarika (IIT Guwahati), “Fundamentals of Artificial Intelligence”.
Link: https://nptel.ac.in/courses/112103280. Useful for the full course.

Deepak Khemani (IIT Madras), “Artificial Intelligence: Search Methods for Problem-Solving”.
Link: https://nptel.ac.in/courses/106106226. Useful for Module 1 and 2

Deepak Khemani (IIT Madras), “Artificial Intelligence: Knowledge Representation and Reasoning”.
Link: https://nptel.ac.in/courses/106106140. Useful for Module 3.

Deepak Khemani (IIT Madras), “AI: Constraint Satisfaction”. Link: https://nptel.ac.in/courses/106106158. Useful for Module 2.

Course Code: CSE2265	Course Title: Essentials of AI Lab Type of Course: Engineering Sciences Core - Lab	L-T-P-C	0	0	2	1
Version No.	1.0					
Course Pre-requisites	CSE1500					
Anti-requisites	NIL					
Course Description	This course introduces the student to the basics of artificial intelligence. In this course, the student first learns the various search methods for problem-solving, followed by knowledge-based logic representations. After that, the student will learn about uncertainty in AI, as well as approaches to solve such challenges such as Naïve Bayes Classifier and Hidden Markov Models. Topics: Uninformed search, Heuristic search, Local search, Adversarial search, Constraint satisfaction, logic, First Order Resolution, Probability, Naïve Bayes Classifier, and Hidden Markov Model (HMM).					
Course Objectives	The objective of the course is EMPLOYBILITY of student by using EXPERIENTIAL LEARNING techniques.					
Course Out Comes	On successful completion of this course the students shall be able to: Explain different methods of searching, proving, and analysis in AI [Understand] Implement various graphical and adversarial search algorithms. [Apply] Prove, by resolution, different situations using First Order Logic [Apply] Solve sequence labeling problems using HMM [Apply]					
Course Content: No. of Sessions: 30 (60 hours)						
NOTE: Each experiment will be run across TWO lab sessions. In the first lab session, the students will have to do a preliminary experiment (Eg. Implement an uninformed search algorithm like BFS). In the second lab session, they will have to test their solution using a given input which is read from a file. Experiment No. 1: File Handling Level 1: Read text files using Python						

Level 2: Parse text files using Python

Experiment No. 2: Implementation of Graph Representations

Level 1: Implement graph representations by taking input from the console

Level 2: Implement graph representations by taking input from files.

Experiment No. 3 & 4: Implementation of Uninformed Search Algorithms

Level 1: Implement uninformed search algorithms – BFS and DFS – on unweighted graphs.

Level 2: Implement uninformed search algorithms – Uniform Cost Search and Dijkstra’s SSSP – on weighted graphs

Experiment No. 5: Implementation of Heuristic Search Algorithms

Level 1: Calculate the upper-bounds of admissible heuristics using Dijkstra’s SSSP.

Level 2: Implement Greedy Best-First Search and A* Search Algorithms.

Experiment No. 6 & 7: Implementation of Adversarial Search

Level 1: Implement a Game Tree

Level 2: Perform Alpha-Beta Pruning and Ideal Ordering

Experiment No. 8 & 9: Implementation of a CSP Solver

Level 1: Implement a CSP solver to solve a cryptarithmetic problem

Level 2: Implement a CSP solver for map colouring

Experiment No. 10: Using Python Packages for CSP

Level 1: Implement a CSP solver for Sudoku

Level 2: Implement a CSP solver for Addoku

Experiment No. 11: Implement a Family Tree Parser

Level 1: Perform logic programming using logpy. Level 2: Implement a family tree parser Experiment No. 12 & 13: Implement a Decision Maker Level 1: Implement a Minesweeper solver Level 2: Implement a Battleship solver Experiment No. 14 & 15: Hidden Markov Model Level 1: Implement a generic HMM Level 2: Build a PoS Tagger using a HMM with the Brown Corpus and the Universal Dependencies Tagset.
Targeted Application & Tools that can be used: Google Colab Python IDEs like PyCharm
Project work/Assignment: Mention the Type of Project /Assignment proposed for this course The course is a lab-based course with all the assessments centrally evaluated. Every experiment consists of two sessions. The first session involves exploring a solution to the problem. The second session involves solving a particular problem.
Textbook(s): Stuart Russel and Peter Norvig. Artificial Intelligence: A Modern Approach. 4th Edition. Pearson Education. 2022. Prateek Joshi and Alberto Artasanchez. Artificial Intelligence with Python. 2nd Edition. Packt. 2020.
References: Deepak Khemani. A First Course in Artificial Intelligence. 1st Edition. 6th Reprint, 2018. Munesh Chandra Trivedi. A Classical Approach to Artificial Intelligence. 2nd Edition. Khanna Publishers. 2018.

Course Code: APT4004	Course Title: Aptitude Training-Intermediate Type of Course: Practical Only Course	L- T - P- C	0	0	2	0
Version No.	1.0					
Course Pre-requisites	Students should have the basic concepts of Quantitative aptitude along with its applications in real life problems.					
Anti-requisites	NIL					
Course Description	This is a skill-based training program for the students. This course is designed to enable the students to enhance their skills in Quantitative Aptitude.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Aptitude and attain Skill Development through Problem Solving techniques.					
Course Out Comes	On successful completion of this course the students shall be able to: CO1: Recall all the basic mathematical concepts. CO2: Identify the principle concept needed in a question. CO3: Solve the quantitative and logical ability questions with the appropriate concept. CO4: Analyze the data given in complex problems.					
Course Content:						
Module 1	Quantitative Ability 1	Assignment			16 Hours	

Topics: Number System, Percentage, Ratio and Proportion, Average, Mixture and Allegation, Time and Work, Profit and Loss

Module 2	Quantitative Ability 2	Assignment	14 Hours
Topics: Time Speed and Distance, Boats and Streams, Simple Interest, Compound Interest, Probability, Permutation and Combination			
Targeted Application & Tools that can be used: Application area: Placement activities and Competitive examinations. Tools: LMS			
Continuous Evaluation:			
CA1 – Online Test CA2 – Online Test CA3 – Online Test Assignment			
Text Book: Fast Track Objective by Rajesh Verma R S Aggarwal Rakesh Yadav References: www.indiabix.com www.testbook.com www.youtube.com/c/TheAptitudeGuy/videos			
Topics relevant to Skill Development: Quantitative aptitude for Skill Development through Problem solving Techniques. This is attained through components mentioned in course handout.			

Course Code: FIN1002	Course Title: Essentials of Finance Type of Course: HSMC		L-T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	This course is designed to be accessible to all students, regardless of their prior financial knowledge.					
Anti-requisites						
Course Description	This course is designed to equip students with a foundational understanding of key financial concepts and principles. It will enable them to comprehend the core functions of finance, delve into the intricacies of financial management within organizations, and gain insights into the fundamental aspects of taxation. The course aims to develop students' abilities to interpret financial statements, evaluate investment opportunities, understand capital structure decisions, and navigate the basics of tax implications.					
Course Objective	Upon successful completion of this course, students will be able to: Understand the basic forms of business organization and their financial implications. Understand the fundamental principles and concepts that influence financial decision-making in various contexts. Analyse and interpret financial statements to assess the financial health and performance of an organization. Identify income under various heads of income as per Income Tax Act, 1961 and determine the tax liability.					
Course Outcomes	List the course outcomes On successful completion of this course the students shall be able to: Understand the basic concepts of finance and financial markets and organizations. Apply and interpret financial information for business decision making. Identify various heads of income and deduction under Income Tax Act, 1961.					
Course Content:						
Module 1	Introduction to Finance	Assignment/ Quiz	Numerical solving Task	10 Sessions		

<table>
<tr><td colspan="5">Definition and Scope of Finance, Areas of Finance: Corporate Finance, Investments, Financial Institutions, International Finance; Types of Financial Markets: Money Markets vs. Capital Markets, Primary vs. Secondary Markets; Forms of Business Organization and Financial Goals: Shareholder Wealth Maximization vs. Profit Maximization; Understanding Financial Statements: Balance Sheet and Income Statement- Simple Numerical.</td></tr>
<tr><td>Module 2</td><td>Financial Management</td><td>Assignment/ Quiz</td><td>Numerical solving Task</td><td>18 Sessions</td></tr>
<tr><td colspan="5">Capital Budgeting Decisions: Payback Period, Net Present Value (NPV), Profitability Index (PI), Internal Rate of Return (IRR); Leverage- Basic Numerical; Capital Structure Decisions: Optimal Capital Structure, Trade-off Theory of Capital Structure; Cost of Capital: Equity, Debt, WACC; Dividend Policy: Factors influencing Dividend Policy.</td></tr>
<tr><td>Module 3</td><td>Taxation</td><td>Assignment/ Quiz</td><td>Numerical solving Task</td><td>17 Sessions</td></tr>
<tr><td colspan="5">Principles of a Good Tax System: Equity, Certainty, Convenience, Economy; Direct vs. Indirect Taxes; Residential Status of an Individual- Basic Problems; Heads of Income; Salary, House Property- Basic Numerical; Deductions under Chapter VI-A; Computation of Taxable Income and Tax Liability; E-Filing procedure.</td></tr>
<tr><td colspan="5">Targeted Application & Tools that can be used:

Textbooks, PPT, Spreadsheet Software (e.g., Microsoft Excel), Official Website of Income Tax Department.</td></tr>
<tr><td colspan="5">Project Work/ Assignment:</td></tr>
<tr><td colspan="5">1. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

2. Case Study: - At the end of the course students will be given a ‘real-world’ cases like business models of successful companies or tax evasion by reputed companies on which they have to come up with detailed analysis and assessment.</td></tr>
<tr><td colspan="5">Text Book(s):

Dr. Vinod K. Singhania & Dr. Monica Singhania. (Latest Assessment Year Edition). Students' Guide to Income Tax including GST. Taxmann Publications.

Pandey, I. M. (2025). Financial Management. Vikas Publishing House.</td></tr>
<tr><td colspan="5">Reference Book (s):</td></tr>
</table>

Bhole, L.M., & Mahakud, J. (Current Edition). Financial Institutions and Markets: Structure, Growth and Innovations. McGraw Hill Education India. Mehrotra, H.C., & Goyal, S.P. (Latest Assessment Year Edition). Income Tax Law & Practice. Sahitya Bhawan Publications. Gordon, E., & Natarajan, K. (Current Edition). Financial Markets and Services. Himalaya Publishing House. Online Resources (e-books, notes, ppts, video lectures etc.): https://presidencyuniversity.linways.com https://onlinecourses.nptel.ac.in/noc24_ec01/preview https://www.incometax.gov.in/iec/foportal/
Topics relevant to “SKILL DEVELOPMENT”: This course is designed to provide practical financial skills through participative learning techniques. Students will engage in performing suitable calculations to determine financial parameters (e.g., time value of money, investment returns, tax liabilities) and analysing financial statements to assess organizational performance and make informed decisions.

Course Code: EEE2511	Course Title: Sensors Actuators for Robotics Type of Course: Professional Core Theory	L-T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	EEE1200 Basics of Electrical and Electronics Engineering					
Anti-requisites	NIL					
Course Description	This course covers topics on fundamentals and applications of several diverse types of sensors, actuators, and their controls. Standard communication protocols between sensors, actuators, and control units will be covered. Moreover, the course will show how to develop sensor and actuator systems for practical applications. Assignments will involve the use of Arduino hardware and software.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Sensors Actuators and Controls and attain Employability Skills through Participative Learning techniques					

Course Outcomes	On successful completion of this course the students shall be able to: Summarize the types of sensors and transducers Explain applications of inductive and capacitive sensors Explain characteristics and applications of actuators Explain the principles and examples of micro sensors and actuators			
Course Content:				
Module 1	SENSORS	Assignment	Problem solving	8 sesssions
Difference between sensor, transmitter, and transducer - Primary measuring elements - selection and characteristics: Range; resolution, Sensitivity, error, repeatability, linearity and accuracy, impedance, backlash, Response time, Dead band. Signal transmission - Types of signals: Pneumatic signal; Hydraulic signal; Electronic Signal. Principle of operation, construction details, characteristics and applications of potentiometer, Proving Rings, Strain Gauges, Resistance thermometer, Thermistor, Hot-wire anemometer, Resistance Hygrometer, Photo-resistive sensor				
Module 2	INDUCTIVE & CAPACITIVE TRANSDUCERs	Assignment	Problem solving	8 Sessions
Inductive transducers: - Principle of operation, construction details, characteristics, and applications of LVDT, Induction potentiometer. Capacitive transducers: - Principle of operation, construction details, characteristics of Capacitive transducers – several types & signal conditioning- Applications: - capacitive pressure sensor, proximity sensor.				
Module 3	ACTUATORS	Assignment	Problem solving	8 Sessions
Definition, types and selection of Actuators; linear; rotary; Logical and Continuous Actuators, Pneumatic actuator- Electro-Pneumatic actuator; cylinder, rotary actuators, Mechanical actuating system: Hydraulic actuator - Control valves; Construction, Characteristics and Types, Selection criteria. Electrical actuating systems: Solid-state switches, Solenoids, Piezoelectric Actuator				
Module 4	MICRO SENSORS AND MICRO ACTUATORS	Assignment	Project development	6 Sessions
Micro Sensors: Principles and examples, Force and pressure micro sensors, position and speed micro sensors, acceleration micro sensors, chemical sensors, biosensors, temperature micro sensors and flow micro sensors. Micro Actuators: Actuation principle, shape memory effects-one way, two way and pseudo elasticity. Types of micro actuators- Electrostatic, Magnetic and Fluidic				

Targeted Application & Tools that can be used: Application Area is Various types of Industries, Robotics, Automation of machines Professionally Used Software: MATLAB/Simulink, Lab-VIEW (NI)
Project Work/ Assignment:
1. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same. 2. Mini Project: - Students will be assigned an hardware mini project which will be displayed in the course based project expo.
Text Book(s): 1. Patranabis.D, "Sensors and Transducers", Wheeler publisher, 1994. 2. Sergej Fatikow and Ulrich Rembold, "Microsystem Technology and Macrobiotics", First edition, Springer - Verlag Newyork, Inc, 1997.
Reference Book (s): Robert H Bishop, "The Mechatronics Handbook", CRC Press, 2002. Thomas. G. Bekwith and Lewis Buck.N, Mechanical Measurements, Oxford and IBH publishing Co. Pvt. Ltd., Massood Tabib and Azar, "Microactuators Electrical, Magnetic, thermal, optical, mechanical, Chemical and smart structures," First edition, Kluwer academic publishers, Springer, 1997. Manfred Kohl, "Shape Memory Actuators", first edition, Springer Online Resources (e-books, notes, ppts, video lectures etc.): Seminar topic: https://www.slideshare.net/saaz1425/dc-motor-23906628 https://www.electricaleasy.com/2014/01/basic-working-of-dc-motor.html Case study: https://www.youtube.com/watch?v=hmP5CSIendo ebook: https://presiuniv.knimbus.com/user#/home
Topics relevant to "EMPLOYIBILITY": Micro Actuators: Actuation principle, shape memory effects-one way, two way and pseudo elasticity. Types of micro actuators- Electrostatic, Magnetic and Fluidic for Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course plan.

<table>
<tr><td>Course Code:
EEE2510</td><td colspan="3">Course Title: Electrical Machines and Drives
Type of Course: Program Core and Theory only</td><td>L- T- P- C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="8">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="8">EEE1200</td></tr>
<tr><td>Anti-requisites</td><td colspan="8">Nil</td></tr>
<tr><td>Course Description</td><td colspan="8">This course provides the basic knowledge of Electrical Drives systems used for robotic applications. It highlights the use of mathematical tools for the analysis of speed and torque characteristics of various motors under steady-state and dynamic conditions. It provides insights into theoretical concepts and enhances the ability to visualize real-world problems in order to provide a solution using various controlling strategies.</td></tr>
<tr><td>Course Objective</td><td colspan="8">The objective of the course is to familiarize the learners with the concepts of Electrical Drives systems for robotic applications and attain Employability Skills through Participative Learning techniques.</td></tr>
<tr><td>Course Out Comes</td><td colspan="8">On successful completion of this course, the students shall be able to:
Explain the various power converters in robotic applications
Explain the dynamics of Electrical drive systems and four-quadrant operation
Analyze the performance of servo motor drives
Analyze the stepper motor drive systems</td></tr>
<tr><td>Course Content:</td><td colspan="8"></td></tr>
<tr><td>Module 1</td><td>Power Converters in Robotic Applications</td><td>Assignment</td><td colspan="3">Simulation task in MATLAB</td><td colspan="3">09 Sessions</td></tr>
<tr><td colspan="9">Topics: Introduction to AC-DC Converters-Single Phase converters, DC-DC Converters-Buck, Boost, Buck-Boost converters. Single-phase half and full-wave AC voltage controller.</td></tr>
<tr><td>Module 2</td><td>Dynamics of Electrical Drives Systems</td><td>Assignment</td><td colspan="3">Hands-on &Programming task</td><td colspan="3">11 Sessions</td></tr>
</table>

Topics: Concept of electric drives, classification and advantages, parts of electrical drives, electric motors, power modulators, sources, choice of electric drives and selection of drives for various applications, types of loads, four-quadrant drive, dependence of load torque on various factors, Dynamics of motor-load combination, Steady state stability of an electric drive system.				
Module 3	Operation and Analysis of Servo-Drive Systems	Assignment	Simulation task in MATLAB	11 Sessions
Topics: Introduction to servo drive systems: Drive system configuration, characteristics of mechanical loads, velocity profiles, matching motor and load, and criteria for selecting drive components. D.C. machine drives: D.C. servo drive characteristics (4-quadrant operation), speed control, development of transfer function for both motor and drive subsystems, A.C. servo drive.				
Module 4	Operation and Analysis of Stepper Motor Drives	Assignment	Developing a controller for a stepper motor	11 Sessions
Topics: Principle of operation, Constructional features, Types of stepper Motors, Various modes of operation of Variable reluctance (VR) stepper motors, torque production in VR stepper motor, Construction and working of Permanent Magnet (PM) stepper motor, Construction and working of Hybrid stepper motor, Torque angle characteristics of the stepper motor.				
Targeted Application & Tools that can be used: The application areas of electrical drives are: Automation industry, robotics professionally used software: MATLAB/Caspoc.				
Text Book G.K DUBEY, "Fundamentals of Electrical Drives", Second edition, Narosa publishing house,2001 W. Shepherd, L. N. Hulley and D. T. Liang, "Power Electronics and motor control", Second Edition, Cambridge University Press, 1995.				
References N.K De and P.K. Sen, "Electrical Drives", PHI. S.K Pillai, "A First Course on Electric Drives", Wiley Eastern Ltd. Bimal K Bose, "Modern Power Electronics and AC Drives" Pearson, 2015.				

online learning resources noc19-ee65-lec01 - YouTube(NPTEL Video Lectures) Dynamic Simulation of Electrical Machines and Drive Systems Using MATLAB GUI | IntechOpen https://www.pdfdrive.com/advanced-electric-drive-vehicles-energy-power-electronics-and-machines-e175341454.html https://www.sciencedirect.com/science/article/abs/pii/S1364032111004308 https://presiuniv.knimbus.com/user#/home
Topics relevant to “EMPLOYABILITY SKILLS”: All the experiments which are listed are for developing Employability Skills through Participative Learning techniques. This is attained through the assessment component mentioned in the course handout.

Course Code: EEE2567	Course Title: Electrical Machines and Drives Lab Type of Course: Program Core & Laboratory	L-T-P- C	0	0	2	1
Version No.	1.0					
Course Pre-requisites	EEE1200					
Anti-requisites	Nil					
Course Description	This course provides the experimental knowledge of Electrical Drives systems used for robotic applications. It highlights the use of mathematical tools for the analysis of speed and torque characteristics of various motors under steady-state and dynamic conditions. It provides insights in validating the theoretical concepts as well as to validate the concepts taught, and enhances the ability to visualize the real-world problems in order to provide a solution using various simulation tools like MATLAB and Caspoc, etc.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Electrical Drives systems for robotic applications and attain Employability Skills through Experiential Learning techniques.					
Basic skill sets required for the laboratory:						

	The students shall be able to develop: An attitude of enquiry. Confidence and ability to tackle new problems. Ability to interpret events and results. Ability to work as a leader and as a member of team. Assess errors and eliminate them. Observe and measure physical phenomenon. Write Reports. Select suitable equipment, instrument and materials. Locate faults in systems. Manipulative skills for setting and handling equipment. The ability to follow standard test procedures. An awareness of the need to observe safety precautions. To judge magnitudes without actual measurement.
Course Out Comes	On successful completion of the course the students shall be able to: Demonstrate the speed control and characteristics of various motors used in robotic applications. Demonstrate the operation of various power electronic converters used in electrical drives systems.
Course Content:	
Experiment No. 1: Stepper Motor Control Using the 8051 Microcontroller Level 1: To obtain the speed vs torque characteristics of the stepper motor at different step angles Level 2: To find out the critical load points of the stepper motor Experiment No. 2: DC Motor Speed Control Using the 8051 Microcontroller Level 1: To obtain the speed characteristics of the DC Motor using PWM Method. Level 2: To obtain the critical speed of the DC Motor using graphical analysis.	

Experiment No. 3: Modelling of a DC Servomotor using MATLAB Simulink.

Level 1: To determine the electrical parameters of the DC Servomotor at different loads.

Level 2: To examine the 4-quadrant characteristics of the DC Servomotor.

Experiment No. 4: Study of Characteristics of AC Servomotor

Level 1: To study the Speed-Torque characteristics of AC Servomotor.

Level 2: To study the Speed-Back EMF characteristics of AC Servomotor at different supply voltages and loads.

Experiment No. 5: Modelling of Variable Reluctance Stepper Motor using MATLAB Simulink

Level 1: To determine the electrical parameters of Variable Reluctance Stepper Motor at different loads.

Level 2: To analyze the dynamic and mechanical characteristics of Variable Reluctance Stepper Motor.

Experiment No. 6: Performance measurement and analysis of a single-phase AC voltage controller

Level 1: Performance measurement and analysis of a single-phase AC voltage controller using virtual lab.

Level 2: Performance measurement and analysis of single-phase AC voltage controller using MATLAB/Simulink.

Experiment No. 7: Single Phase semi-converter with R Load, RL Load & RLE Load

Level 1: Single Phase semi-converter with R Load, RL Load & RLE Load using virtual lab

Level 2: Single Phase semi-converter with R Load, RL Load & RLE Load using MATLAB/Simulink.

Experiment No. 8: Performance measurement and analysis of a non-isolated DC-DC boost converter

Level 1: Performance measurement and analysis of a non-isolated DC-DC boost converter using virtual lab

Level 2: Performance measurement and analysis of a non-isolated DC-DC boost converter using MATLAB/Simulink.

Targeted Application & Tools that can be used:

The application areas of electrical drives are: Automation industry, robotics professionally used software: MATLAB/Caspoc.

Course Material

Electrical machines and Drives Lab Manual, Presidency University, Bengaluru. Text Book: G.K DUBEY, "Fundamentals of Electrical Drives", Second edition, Narosa publishing house, 2001. W. Shepherd, L. N. Hulley and D. T. Liang, "Power Electronics and motor control", Second Edition, Cambridge University Press, 1995. Reference Books: N.K De and P.K. Sen, "Electrical Drives", PHI. S.K Pillai, "A First Course on Electric Drives", Wiley Eastern Ltd. Bimal K Bose, "Modern Power Electronics and AC Drives" Pearson, 2015.
Online resources: noc19-ee65-lec01 - YouTube(NPTEL Video Lectures) Dynamic Simulation of Electrical Machines and Drive Systems Using MATLAB GUI | IntechOpen https://www.pdfdrive.com/advanced-electric-drive-vehicles-energy-power-electronics-and-machines-e175341454.html https://www.sciencedirect.com/science/article/abs/pii/S1364032111004308 https://presiuniv.knimbus.com/user#/home https://pe-iitr.vlabs.ac.in/List%20of%20experiments.html
Topics relevant to "EMPLOYABILITY SKILLS": All the experiments which are listed are for developing Employability Skills through Experiential Learning techniques. This is attained through the assessment component mentioned in the course handout.

Course Code: MAT2503	Course Title: Transform Techniques, Partial Differential Equations and Complex Variables Type of Course:1] School Core		L-T- P- C	3	1	0	4
Version No.		1.0					
Course Pre-requisites		MAT2301 & MAT2303					
Anti-requisites		NIL					

Course Description		This course aims to introduce various transform techniques such as Laplace transform, Fourier transform and Z-transform in addition to expressing functions in terms of Fourier series. The course covers applications of Laplace transform to LCR circuits and solutions of different equations using Z-transform. The course also deals with the analytical methods for solving partial differential equations and the classical applications of partial differential equations. Complex variables studies function where both the independent and dependent variables are complex numbers, exploring concepts like differentiation, integration, power series, contour integration, and singularities within the complex plane.		
Course Objective		The objective of the course is to familiarize the learners with the concepts of "Transform Techniques, Partial Differential Equations and Complex Variables" and attain Skill Development through Problem Solving Techniques.		
Course Out Comes		On successful completion of the course the students shall be able to: CO1 - Express functions in terms of uniformly convergent Fourier series. CO2 - Apply Laplace transform technique to solve differential equations. CO3 - Employ Z-transform techniques to solve difference equations. CO4 - Solve a variety of partial differential equations analytically.		
Course Content:				
Module 1	Laplace Transforms			(8 Classes)
Definition and Laplace transforms of elementary functions. Properties of Laplace transform, and Laplace transform of periodic function, unit-step function and Impulse function – related problems. Inverse Laplace transform of standard functions - problems, initial and final value theorem. Convolution theorem, solution of linear and simultaneous differential equations and LCR Circuit.				
Module 2	Fourier Series			(6 Classes)
Fourier Series: Periodic functions, Dirichlet's condition. Fourier series of periodic functions period 2π and arbitrary period. Half range Fourier series. Practical harmonic analysis.				
Module 3	Fourier Transforms and Z - Transforms		Assignment	(9 Classes)
Fourier Transforms: Definitions, infinite Fourier transforms, Fourier sine and cosine transforms, inverse Fourier transforms, Problems. Difference equations and Z-transforms: Z-transforms – Basic definitions, Standard Z-transforms, Linearity property, Damping rule, Shifting rule, Initial value theorem, Final value theorem, Inverse				

Z-transforms. Difference equations – Basic definitions, Application of Z-transforms to solve difference equations.			
Module 4	Partial Differential Equations		(9 Classes)
Formation of PDE, Solution of non-homogeneous PDE by direct integration, Solution of homogeneous PDE involving derivative with respect to one independent variable only (Both types with given set of conditions) Method of separation of variables. (First and second order equations) Solution of Lagrange's linear PDE. of the type P p + Q q = R. Applications of PDE: Derivation of one-dimensional wave and heat equations. Various possible solutions of these by the method of separation of variables. D'Alembert's solution of wave equation. Two-dimensional Laplace's equation – various possible solutions. Solution of all these equations with specified boundary conditions (Boundary value problems).			
Module 5	Complex Variables	Assignment	(12 Classes)
Introduction, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; Conformal mappings. Complex Integration: Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof).			
Targeted Application & Tools that can be used: The objective of the course is to familiarize students with a variety of numerical techniques and the theoretical concepts of probability and statistics to equip them with the necessary numerical approaches and basic statistical tools to tackle engineering and real-life problems.			
Assignment:			
Newton-Raphson Methods, Gauss-Seidel Method, LU Decomposition, Trapezoidal Rule, Simpson's rule, Runge-Kutta 4th Order.			
Text Book Erwin Kreyzig, Advanced Engineering Mathematics, John Wiley and sons, Inc.10th Edition B. S. Grewal (2017), Higher Engineering Mathematics by, 44th Edition, Khanna Publishers.			
References: Victor Henner, Tatyana Belozerova, Mickhail Khenner, Ordinary and Partial Differential Equations, CRC Press, Edition, 2013. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering, Computations, 6th Edition, New age Publishing House, 2015.			

Walter Ledermann, Multiple integrals, Springer, 1st edition. C. Ray Wylie and Louis C Barrett, "Advanced Engineering Mathematics", 6th Ed, McGraw-Hill, 2012. E-resources/ Web links: https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_140238 https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_233298 https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_204892 https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_246791 https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_223548 https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_134719 https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_32614 https://www.math.hkust.edu.hk/~maqian/ma006_0607F.html https://www.scu.edu.au/study-at-scu/units/math1005/2022/
Topics relevant to SKILL DEVELOPMENT: This course aims to introduce various transform techniques such as Laplace transform, Fourier transform, and Z transform in addition to expressing functions in terms of Fourier series. The course covers applications of Laplace transform to LCR circuits and solution of difference equations using z-transform. The course also deals with the analytical methods for solving partial differential equations and the classical applications of partial differential equations. Overall, this course provides the knowledge of transform techniques and partial differential equations for Skill Development through Problem Solving methodologies. This is attained through assessment component.

Course Code: MEC2029	Course Title: Hydraulics and Pneumatics Type of Course:	L-T-P-C	3	0	0	3

	1] Professional Core Course 2] Theory			
Version No.	2.0			
Course Pre-requisites	NIL			
Anti-requisites	NIL			
Course Description	Automobiles, missiles, machine tools, aero planes etc. extensively use fluid power technology. This course deals with the fundamental aspects of hydraulics and pneumatics, the two fields of relevance to fluid power engineering.			
Course Objectives	The objective of the course is to familiarize the learners with the concepts of "Hydraulics and Pneumatics" and attain Skill Development through Problem solving methodologies.			
Course Out Comes	On successful completion of the course the students shall be able to: 1] Describe the fundamentals of Hydraulic Power Pumps, Actuators and Motors. 2] Explain control components in Hydraulic Systems. 3] Solve the numerical problems related to hydraulic efficiency of motors. 4] Describe the fundamentals of pneumatic system, Actuators, Valves, Pneumatic circuits and logic circuits.			
Course Content:				
Module 1	Introduction to Hydraulic System	Assignment	Data collection	10 sessions
Topics: Introduction to Hydraulic Power and Pumps: Review of fluid mechanics, Pascal's Law, structure of hydraulic control system. pumps: pumping theory, pump classification, gear pumps- external and internal type, vane pumps- simple, balanced, pressure compensated types, piston pumps- radial and axial (both swash plate and bent axis type), pump performances. Hydraulic Actuators and Motors: Linear hydraulic actuators - single acting, double acting, tandem cylinder, telescopic rod cylinder, mechanics of hydraulic cylinder loading, cylinder cushioning, hydraulic rotary actuators, hydrostatic transmission – open and close circuit, performance of hydraulic motor.				

<table>
<tr><td>Module 2</td><td>Energy transfer in hydraulic actuators and motors</td><td>Case study</td><td>Identify various valves considering a hydraulic system.</td><td>12 sessions</td></tr>
<tr><td colspan="5">Topics: Directional control valves (DCV), Constructional features, 2/2,3/2,4/2,4/3 DCV, Center configuration in 4/3 DCV- open, closed, tandem, regenerative, floating center configuration, Actuation of DCVs- manual, mechanical, solenoid, and indirect actuation, Relays for the solenoid operation, Check valve, Pilot check valve, Pressure control valves – Direct and Pilot operated types, Pressure reducing valve, Flow control valves- fixed throttle, and variable throttle, Throttle check valve, Pressure compensated flow control valve- relief and reducing types</td></tr>
<tr><td>Module 3</td><td>Introduction to Pneumatic System and its control</td><td>Assignment</td><td>Data Collection</td><td>12 sessions</td></tr>
<tr><td colspan="5">Topics: Choice of working medium, Characteristics of compressed air, structure of pneumatic control system, supply, signal generators, signal processor, final control elements , actuators, production of compressed air – compressors - reciprocating and rotary type, preparation of compressed air – driers, filters, regulators, lubricators, distribution of compressed air – piping layout.

Pneumatic memory valve, time delay valve. Pneumatic circuits and logic circuits: supply air and exhaust air throttling, will dependent circuits, travel dependent controls – types – construction – practical applications, cylinder sequencing circuits, travel step diagrams, practical examples involving two or three cylinders, use of logic functions in pneumatic manufacturing applications, practical examples involving the use of logic functions.</td></tr>
<tr><td>Module 4</td><td>Electro-Pneumatic control</td><td>Assignment</td><td>Data Collection</td><td>11 sessions</td></tr>
<tr><td colspan="5">Topics: Principles-signal input and output pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple single cylinder applications.</td></tr>
<tr><td colspan="5">Targeted Application & Tools that can be used:

This course finds applications mainly in automobile, space, defense, medical, consumer goods etc. Job titles might include Hydraulic or Pneumatic Design engineer, Maintenance engineer, Quality engineer, Service Engineer, Application engineer.</td></tr>
<tr><td colspan="5">Text Book

T1: Fluid Power with applications, Anthony Esposito, Fifth edition Pearson education, Inc. 2000.

T2: Pneumatics and Hydraulics, Andrew Parr. Jaico Publishing Co. 2000.</td></tr>
</table>

T3: Hydraulics and Pneumatics, Dr.Niranjan Murthy and Dr.R.K.Hegde, Sapna Publications, 2013
References R1: Oil Hydraulic Systems - Principles and Maintenance, S.R. Majumdar, Tata Mc Graw Hill Publishing company Ltd. 2001. R2: Pneumatic Systems, S.R. Majumdar, Tata Mc Graw Hill publishing Co., 1995. R3: Industrial Hydraulics, Pippenger, Hicks, McGraw Hill, New York, 2009
Web Links: https://nptel.ac.in/courses/112/106/112106300/ W1: https://presiuniv.knimbus.com/user#/searchresult?searchId=hydraulics%20and%20pnumatics&_t=1656929386018 Hydraulics and Pnumatics
Topics relevant to "EMPLOYABILITY SKILLS": Signal input and output pilot assisted solenoid control of directional control valves, use of relay and contactors for developing SKILLS DEVELOPMENT through Problem Solving methodologies. This is attained through assessment component mentioned in course plan.

Course Code: RAI2002	Course Title: Robot Operating System Type of Course: Theory only	L- T-P- C	3	0	0	3

<table>
<tr><td>Version No.</td><td colspan="4">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="4">NIL</td></tr>
<tr><td>Anti-requisites</td><td colspan="4">NIL</td></tr>
<tr><td>Course Description</td><td colspan="4">This course introduces the Robot Operating System (ROS) framework, an open-source platform that provides libraries and tools to help software developers create robot applications. Students will learn about ROS architecture, communication mechanisms, visualization, and integration with sensors and actuators. Emphasis will be placed on hands-on learning through simulations and real-world applications.</td></tr>
<tr><td>Course Objective</td><td colspan="4">To equip students with essential knowledge and hands-on skills in using ROS for robot software development, sensor integration, communication, and control.</td></tr>
<tr><td>Course Outcomes</td><td colspan="4">Understand the architecture, tools, and communication structure of ROS. (Understand)

Create ROS nodes and packages for robot behavior. (Apply)

Interface sensors and actuators using ROS topics and services. (Analyze)

Build integrated robotic applications in simulation and real hardware. (Create)</td></tr>
<tr><td colspan="5">Course Content:</td></tr>
<tr><td>Module 1</td><td>Introduction to ROS and Architecture</td><td>Understand</td><td></td><td>11

Sessions</td></tr>
<tr><td colspan="5">Basics of ROS, nodes, topics, services, messages, master, parameter server, ROS file system, ROS distributions.</td></tr>
<tr><td>Module 2</td><td>ROS Communication and Tools</td><td>Apply</td><td></td><td>11

Sessions</td></tr>
<tr><td colspan="5">ROS nodes and packages, publishing/subscribing to topics, launching nodes, using rosbag, rviz, and rqt for debugging and visualization.</td></tr>
<tr><td>Module 3</td><td>Sensor and Actuator Integration</td><td>Analyze</td><td></td><td>11

Sessions</td></tr>
</table>

Working with ROS drivers, interfacing sensors (LIDAR, IMU, camera), reading sensor data, commanding motors, TF (transform library).				
Module 4	Simulation and Real-Time Applications	Create		12 Sessions
Gazebo simulation, ROS Navigation Stack, SLAM, autonomous navigation, multi-robot communication, ROS2 basics.				
Project work/Assignment:				
Assignment 1 on Module 1 and Module 2 Assignment 2 on Module 3 and Module 4				
TEXTBOOKS; 1. Aaron Martinez and Enrique Fernández, “Learning ROS for Robotics Programming”, 2nd Edition, Packt Publishing, 2015. Wyatt Newman, “A Systematic Approach to Learning Robot Programming with ROS”, CRC Press, 2017. REFERENCE MATERIALS: Morgan Quigley, Brian Gerkey, William D. Smart, “Programming Robots with ROS”, O'Reilly Media, 2015. Jason M. O’Kane, “A Gentle Introduction to ROS”, 2013 (online textbook). Lentin Joseph, “Mastering ROS for Robotics Programming”, Packt Publishing, 2015.REFERENCES JOURNALS/MAGAZINES SWAYAM/NPTEL/MOOCs:				

Course Code: RAI2003	Course Title: Robot Operating System Lab Type of Course: Laboratory only	L- T-P- C	0	0	2	1
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	This course introduces the Robot Operating System (ROS) framework, an open-source platform that provides libraries and tools to help software developers create robot applications. Students will learn about ROS architecture, communication mechanisms, visualization, and integration with sensors and actuators. Emphasis will be placed on hands-on learning through simulations and real-world applications.					
Course Objective	To equip students with essential knowledge and hands-on skills in using ROS for robot software development, sensor integration, communication, and control.					
Course Outcomes	Understand the architecture, tools, and communication structure of ROS. (Understand) Create ROS nodes and packages for robot behavior. (Apply) Interface sensors and actuators using ROS topics and services. (Analyze) Build integrated robotic applications in simulation and real hardware. (Create)					
Course Content:						

List of Laboratory Tasks:

Lab 1: ROS Installation and Workspace Setup

Objective: Set up and configure ROS workspace on Ubuntu OS.

Lab 2: Creating and Running ROS Nodes

Objective: Develop and run publisher and subscriber nodes using Python/C++.

Lab 3: Visualizing Data with rviz

Objective: Publish simulated data and visualize robot state using rviz.

Lab 4: Simulating a TurtleBot in Gazebo

Objective: Control a virtual robot in simulation using ROS commands.

Lab 5: Sensor Integration (Camera/IMU/LIDAR)

Objective: Use ROS packages to read and process data from real/simulated sensors.

Lab 6: Mapping and Navigation with SLAM

Objective: Implement SLAM on a TurtleBot and create a 2D map of the environment.

Lab 7: Path Planning Using ROS Navigation Stack

Objective: Design and execute a robot’s path to reach a goal point autonomously.

Lab 8: ROS2 Introduction and Basic Nodes

Objective: Explore the new features and write basic nodes in ROS2.

TEXTBOOKS;

1. Aaron Martinez and Enrique Fernández, “Learning ROS for Robotics Programming”, 2nd Edition, Packt Publishing, 2015.

Wyatt Newman, “A Systematic Approach to Learning Robot Programming with ROS”, CRC Press, 2017.

REFERENCE MATERIALS:

Morgan Quigley, Brian Gerkey, William D. Smart, “Programming Robots with ROS”, O'Reilly Media, 2015.

Jason M. O’Kane, “A Gentle Introduction to ROS”, 2013 (online textbook).

Lentin Joseph, “Mastering ROS for Robotics Programming”, Packt Publishing, 2015.REFERENCES

JOURNALS/MAGAZINES

SWAYAM/NPTEL/MOOCs:

Course Code: CSE7000	Course Title: Internship Type of Course:	L- T-P- C	0	0	0	2
Version No.	1.0					
Course Pre-requisites	Knowledge and Skills related to all the courses studied in previous semesters.					
Anti-requisites	NIL					
Course Description	Students observe science and technology in action, develop an awareness of the method of scientific experimentation, and often get an opportunity to see, study and operate sophisticated and costly equipment. They also learn about the implementation of the principles of management they have learnt in class, when they observe multidisciplinary teams of experts from engineering, science, economics, operations research, and management deal with techno-economic problems at the micro and macro levels. Finally, it enables them to develop and refine their language, communication and inter-personal skills, both by its very nature, and by the various evaluation components, such as seminar, group discussion, project report preparation, etc. The broad-based core education, strong in mathematics and science and rich in analytical tools, provides the foundation necessary for the student to understand properly the nature of real-life problems.					
Course Objectives	The objective of the course is to familiarize the learners with the concepts of Professional Practice and attain Employability Skills through Experiential Learning techniques.					
Course Outcomes	On successful completion of this course the students shall be able to: Identify the engineering problems related to local, regional, national or global needs. (Understand) Apply appropriate techniques or modern tools for solving the intended problem. (Apply)					

	Design the experiments as per the standards and specifications. (Analyze) Interpret the events and results for meaningful conclusions. (Evaluate)

<table>
<tr><td>Course Code: APT4006</td><td>Course Title: Logical and Critical Thinking

Type of Course: Audited</td><td>L- T-P- C</td><td>0</td><td>0</td><td>2</td><td>0</td></tr>
<tr><td>Version No.</td><td colspan="6">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="6">Students should have the basic concepts of Logical reasoning and Critical thinking, along with its applications in real life problems.</td></tr>
<tr><td>Anti-requisites</td><td colspan="6">Nil</td></tr>
<tr><td>Course Description</td><td colspan="6">This is a skill-based training program for the engineering students (Undergraduate). This course is designed to enable the students to enhance their skills in Logical reasoning and Critical thinking.</td></tr>
<tr><td>Course Objective</td><td colspan="6">The objective of the course is to familiarize the learners with concepts in in Logical reasoning and Critical thinking through problem solving techniques suitable for their career development.</td></tr>
<tr><td rowspan="4">Course Outcomes</td><td colspan="6">On successful completion of the course the students shall be able to:</td></tr>
<tr><td colspan="6">CO1] Understand all the concepts.</td></tr>
<tr><td colspan="6">CO2] Apply the concepts in problem solving (Bloom’s taxonomy Level 3)</td></tr>
<tr><td colspan="6">CO3] Analyze and structure the reasoning techniques and spatial visualization skills</td></tr>
<tr><td colspan="7">Course Content:</td></tr>
<tr><td>Module 1</td><td>Logical Thinking</td><td>Assignment</td><td colspan="3"></td><td>16 Hours</td></tr>
<tr><td rowspan="2"></td><td colspan="6">Topics:</td></tr>
<tr><td colspan="6">Syllogisms, Cubes and Dices, Mirror and Water images, Paper cutting and Folding, Embedded figures & Completion of figures, Data Interpretation, Data sufficiency</td></tr>
<tr><td>Module 2</td><td>Critical Thinking</td><td>Assignment</td><td colspan="3"></td><td>14 Hours</td></tr>
<tr><td rowspan="2"></td><td colspan="6">Topics:</td></tr>
<tr><td colspan="6">Analogy, Symbol and Notations, Statement and assumption, Cause of action, Statement and conclusion, Puzzles</td></tr>
<tr><td rowspan="2"></td><td colspan="6">Targeted Application & Tools that can be used:</td></tr>
<tr><td colspan="6">Application area: Placement activities and Competitive examinations.</td></tr>
</table>

	Tools: LMS
Evaluation	Continuous Evaluation
	· Topic wise evaluation
	· Internal Assessments
	Text Book
	1. A new approach to reasoning verbal, non-verbal & analytical by BS Sijwali
	2. R S Aggarwal
	3. Kiran publications
	References
	1. www.indiabix.com
	2. www.testbook.com
	3. www.youtube.com/c/TheAptitudeGuy/videos
	Topics relevant to Skill Development Logical reasoning and Critical thinking for Skill Development through Problem solving Techniques. This is attained through assessment component mentioned in course handout.

Course Code: ECE2532	Course Title: Communication Systems for Robotics Type of Course: Program Core	L-T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	ECE2530					
Anti-requisites	NIL					
Course Description	This course focuses on the communication protocols essential for robotic systems, covering both wired and wireless communication standards, fieldbus systems, middleware frameworks, and industrial communication protocols. Emphasis is placed on real-time, reliable, and deterministic data exchange among sensors, actuators, controllers, and robot-to-robot or robot-to-infrastructure communication.					

Course Objective	The objective of the course is to familiarize the learners with the concepts of Communication protocols used in Robotics to improve the learners' Employability Skills by Participative Learning.			
Course Outcomes	On successful completion of this course the students shall be able to: Explain the fundamentals of communication protocols and their significance in robotics. Analyze and compare various wired protocols such as UART, SPI, I2C, CAN, and industrial fieldbus systems. Implement and evaluate wireless protocols including Wi-Fi, Bluetooth, ZigBee, and industrial wireless standards for robotics.			
Course Content:				
Module 1	Fundamentals of Communication Protocols in Robotics	Quiz	Memory Recall based Quizzes	9 sessions
Topics: Introduction to Communication Protocols and OSI Model for Robotics, Difference between Communication Systems and Protocols, Signal Encoding and Framing Techniques, Error Detection and Correction Methods, Time Determinism and Real-Time Constraints, Fundamentals of Serial Communication: UART, RS232 and RS485, Introduction to SPI and I2C for Sensor-Actuator Communication, Protocol Stack Implementation on Microcontrollers, Case Study: Protocol Selection for Mobile Robot Control.				
Module 2	Wired and Fieldbus Protocols for Robotics	Quiz, Mid Term Exam	Memory Recall based Quizzes, Mid Term Exam	12 sessions
Topics: CAN Bus: Protocol Structure, Arbitration, and Implementation in Automotive Robotics, Controller Area Network FD and CANOpen for Industrial Robots, LIN Protocol and its Applications in Robotic Subsystems, Industrial Fieldbus Systems: PROFIBUS, PROFINET, EtherCAT, Modbus and Ethernet/IP for Factory Automation, DeviceNet and CC-Link Overview, Signal Integrity and Wiring Standards in Robotic EtherCAT Networks, Case Study: Implementing EtherCAT in Collaborative Robots, Fieldbus vs. Ethernet-based Industrial Protocols.				
Module 3	Wireless Protocols for	Assignment	Programming Assignment	12 sessions

	Robotic Communication			
Topics: Wireless Channel Characteristics in Indoor and Outdoor Robotic Environments, Wi-Fi (IEEE 802.11) Standards and Mesh Networking for Robots, Bluetooth Low Energy (BLE) for Robotic Peripheral Communication, ZigBee (IEEE 802.15.4) and Thread in Sensor Networks, LoRaWAN and LPWAN Technologies for Long-Range Robotics Applications, Industrial Wireless Protocols: WirelessHART and ISA100, Designing Robust Wireless Networks for Robot Swarms, Interference Mitigation and Frequency Planning in Multi-Robot Systems, Case Study: Wireless Communication Setup for Autonomous Drone Fleet.				
Module 4	Networked Protocols and Middleware for Robotics	End Term Exam	End Term Exam	12 sessions
Topics: TCP/IP Stack Implementation on Embedded Systems, UDP and Real-Time Transport Protocols, Time-Sensitive Networking (TSN) Fundamentals and Standards, Data Distribution Service (DDS) in ROS2 for Real-Time Robotics, MQTT and MQTT-SN for IoT-Enabled Robotic Systems, ZeroMQ and Custom Middleware Solutions, Security Protocols: TLS/DTLS, VPNs and Secure Boot for Robots, Edge and Cloud Communication Architectures for Robotics, Case Study: ROS2 Middleware Deployment on Multi-Robot System.				
List of Laboratory Tasks: Nil				
Targeted Application & Tools that can be used: Targeted Applications: Targeted Applications: Autonomous Vehicles, Industrial Automation, Drone Networks, IoT-Connected Robots Professionally Used Software/Hardware: MATLAB/Simulink, Raspberry Pi, STM32CubeMX, ROS/ROS2, Wireshark, CANoe, Node-RED				
Text Book(s): John S. Rinaldi, "Real-Time Ethernet: Industrial Performance and Protocols", Wiley, 2015. Frank Vahid, "Embedded Systems Design with the ARM Cortex-M3", Elsevier, 2009. Wolfgang Mierendorff, "Robotics Middleware", Springer, 2020. Guoqiang Zhu, "Modbus Application Protocol Specification", Modbus Organization, 2016.				
Reference(s): Reference Book(s):				

Boss, D., "Controller Area Network Basics", Microchip Press, 2014.

Zhou, R., Kou, G., "Wireless Communication in Unmanned Aerial Vehicles", IEEE Press, 2018.

Thrun, S., Burgard, W., Fox, D., "Probabilistic Robotics", MIT Press, 2005. (Chapter on Communication Protocols)

Kracic, M., "IoT Protocols for Robotics", CRC Press, 2019.

Online Resources (e-books, notes, ppts, video lectures etc.):

ROS Communication Tutorials: http://wiki.ros.org/ROS/Tutorials

IEEE Xplore: Search for "Robotics Communication Protocols" (https://ieeexplore.ieee.org/)

NPTEL: Embedded Systems and Communication Protocols (https://nptel.ac.in/)

OpenEtherCAT Linux Project: https://www.opene

E-content:

F. Meadowcroft, T. Fisher, and M. Ritchings, “Survey and Performance Evaluation of Wireless Communication Protocols for Mobile Robots,” IEEE Communications Surveys & Tutorials, vol. 16, no. 2, pp. 801–820, 2nd Quarter 2014.
DOI not available

P. Müller, A. Kölsch, and D. Pitt, “EtherCAT for Robotics: Real-Time Networking Performance,” IEEE Transactions on Industrial Electronics, vol. 65, no. 10, pp. 8037–8046, Oct. 2018.
doi: 10.1109/TIE.2018.2830005 (ResearchGate, ResearchGate)

Y. Wu, B. Cheng, and L. Shi, “Application of Time-Sensitive Networking (TSN) in Industrial Robotics,” IEEE Transactions on Industrial Informatics, vol. 15, no. 6, pp. 3480–3489, Jun. 2019.
doi: 10.1109/TII.2019.2912237 (ACM Digital Library)

C. Stergiopoulos and J. Gill, “Performance Evaluation of ROS 2 DDS for Real-Time Robotic Applications,” in Proc. IEEE International Conference on Robotics and Automation (ICRA), Montréal, QC, Canada, May 2019, pp. 2178–2184.
doi: 10.1109/ICRA.2019.8793652 (ResearchGate)

M. Trentmann, M. Bechler, and H. Van (Van De Wouw), “CAN-FD in Robotics: Enhanced Determinism and Performance,” in Proc. IEEE International Conference on Mechatronics and Automation, Tianjin, China, Aug. 2018, pp. 1323–1328.
doi: 10.1109/ICMA.2018.8484317 (ACM Digital Library)

A. H. Vargas-Luna, F. G. Márquez, and P. A. Torres, “Securing Robot-to-Robot Communication using TLS in ROS,” in Proc. IEEE International Conference on Robotics and Biomimetics (ROBIO), Macau, China, Dec. 2017, pp. 1562–1568.
doi: 10.1109/ROBIO.2017.8324801 (MDPI)

J. R. Dean and R. D. Howe, “Time-Triggered Ethernet: A Real-Time Communication Standard for Robotics and Automation,” IEEE Transactions on Industrial Informatics, vol. 12, no. 6, pp. 2288–2296,

Dec. 2016. doi: 10.1109/TII.2016.2636370 (MDPI) R. F. Tranquilli and C. B. Cheeseman, “Transport Security in Multi-Robot Systems,” in Proc. IEEE International Conference on Robotics and Automation (ICRA), Singapore, May 2017, pp. 468–475. doi: 10.1109/ICRA.2017.7989165 (arxiv.org)
Topics relevant to “EMPLOYABILITY SKILLS”: Developing real-time communication stacks for robotics applications, Hands-on implementation of industrial communication protocols, Experience with wireless network design and troubleshooting for robots, Integration of middleware frameworks for multi-robot coordination, Security protocol implementation and assessment for robotic platforms for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Course Code: CSE2271	Course Title: Software Design and Development Type of Course: School Core [Theory Only]	L-T- P- C	3-0-0-3
Version No.	1.0		
Course Pre-requisites	NIL		
Anti-requisites	NIL		
Course Description	The objective of this course is to provide the fundamentals concepts of Software Engineering process and principles. The course covers software requirement engineering processes, system analysis, design, implementation and testing aspects of software system development. The course covers software quality, configuration management and maintenance.		
Course Objectives	The objective of the course is to familiarize the learners with the concepts of Software Engineering and attain Skill Development through Participative Learning techniques.		
Course Out Comes	On successful completion of this course the students shall be able to: 1] Describe the Software Engineering principles, ethics and process models(Knowledge)		

<table>
<tr><td></td><td colspan="4">2] Identify the requirements, analysis and appropriate design models for a given application(Comprehension)

3] Understand the Agile Principles(Knowledge)

4] Apply an appropriate planning, scheduling, evaluation and maintenance principles involved in software(Application)</td></tr>
<tr><td></td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>Introduction to Software Engineering and Process Models

(Knowledge level)</td><td>Quiz</td><td></td><td>10 Hours</td></tr>
<tr><td colspan="5">Introduction: Need for Software Engineering, Professional Software Development, Software Engineering Ethics, Software Engineering Practice-Essence of Practice, General Principles Software Development Life Cycle

Models: Waterfall Model – Classical Waterfall Model, Iterative Waterfall Model, Evolutionary model-Spiral, Prototype.</td></tr>
<tr><td>Module 2</td><td>Software Requirements, Analysis and Design

(Comprehension level)</td><td>Assignment</td><td>Development of SRS documents for a given scenario</td><td>12 Hours</td></tr>
<tr><td colspan="5">Requirements Engineering: Eliciting requirements, Functional and non- Functional requirements, Software Requirements Specification (SRS), Requirement Analysis and validation. Requirements modelling- Introduction to Use Cases, Activity diagram and Swim lane diagram. CASE support in Software Life Cycle, Characteristics of CASE Tools, Architecture of a CASE Environment.

Design: Design concepts, Architectural design, Component based design, User interface design.</td></tr>
<tr><td>Module 3</td><td>Agile Principles & Devops

(Knowledge level)</td><td>Quiz</td><td></td><td>10 Hours</td></tr>
<tr><td colspan="5">Agile: Scrum Roles and activities, Sprint Agile software development methods - Scaling, User Stories, Agile estimation techniques, Product backlogs, Stake holder roles, Dynamic System Development Method.

Devops: Introduction, definition, history, tools.</td></tr>
<tr><td>Module 4</td><td>Software Testing and Maintenance

(Application Level)</td><td>Assignment</td><td>Apply the testing concepts using Programing</td><td>13 Hours</td></tr>
</table>

Software Testing-verification and validation, Test Strategies - White Box Testing, Black box Testing. Automation Tools for Testing. Software Quality Assurance-Elements of software quality assurance, SQA Tasks, Goals and Metrics, Software configuration management- SCM process, SCM Tools (GitHub). Maintenance- Characteristics of Software Maintenance, Software Reverse Engineering, Software Maintenance Process Models.
Targeted Application & Tools that can be used: Selenium, GitHub, CASE Tools
Text Book 1] R1. Roger S. Pressman, “Software Engineering – A Practitioner’s Approach”, VII Edition, McGraw-Hill, 2017. 2] B2. Bob Hughes, Mike Cotterell, Rajib Mall, “Software Project Management”, VI Edition, McGraw-Hill, 2018.
References Rajib Mall, “Fundamentals of Software Engineering”, VI Edition, PHI learning private limited, 2015. Ian Sommerville, “Software Engineering”, IX Edition, Pearson Education Asia, 2011. Agile Software Development Principles, Patterns and Practices.1st Edition, Wiley, 2002
Topics Relevant to “Skill Development: Balck box Testing, White box Testing, Automated Testing for Skill development through Participative Learning Techniques. This is attained through assessment mentioned in the course handout

Course Code: CSE2274	Course Title: Competitive Programming and Problem Solving Type of Course: Program Core	L-T-P-C	0	0	4	2
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	The Competitive Programming and Problem Solving course equips students with efficient problem-solving skills for coding competitions and real-world challenges. Starting with brute-force solutions, students learn to optimize time and space complexity using advanced techniques like dynamic programming,					

	greedy algorithms, and backtracking. Hands-on practice on platforms like CodeChef and Codeforces helps tackle problems involving number theory, data structures, and algorithmic paradigms. By understanding CP constraints and fostering a strategic mindset, students gain the confidence to excel in competitions, technical interviews, and practical applications.
Course Out Comes	On successful completion of the course the students shall be able to: CO1 : Understanding the issues of online platforms and Competitive Programming (CP) and developing brute force coding for commonly asked CP problems. CO2 : Analyzing the space and time complexity of brute force solutions and designing efficient solutions. CO3 : Evaluating the applicability of suitable algorithmic approaches to solve relevant CP problems. CO4: Creating efficient solutions of CP problems using the learnt algorithmic approaches.
Course Objective	The objective of the course is to familiarize the learners with the concepts of Competitive Programming and Problem Solving and attain Skill Development through Experiential Learning techniques.

Module 1: Introduction to Competitive Programming

Overview of Efficient Coding for Problem Solving and CP: Introduction to competitive programming (CP); revisit of complexity analysis; introduction to online platforms such as codechef, codeforces etc and online submission; constraints during CP, online testing process and common errors such as TLE; use of STL

Module 2: Number Theory for Problem-Solving

Use of Number Theory for problem-solving: reducing time/space complexity of brute force coding solution of Sieve Method, Inverse Module, Euclidian Method of factorization; efficient coding for Permutation Combination; XORing based and pattern-based solutions.

Module 3: Optimizing Time & Space Using Sequential Storage

Coding for Optimizing time and Space using Sequential Storage: two pointer approach; problem-solving using arrays and strings such as rotation on sorted arrays, duplicate removal, string matching algorithms; Kadane’s algo, stacks, priority-queues and hashing based efficient coding; median based problems and alternate solutions.

Module 4: Non-Linear Data Structures

Applying Non-Linear Data Structures for real-life problems: design of efficient solutions for problems such as finding loops in a linked list, memory efficient DLL, block reversal in LL; problem solving using trees and binary trees, Catalan numbers, applications of graphs, spanning tree and path algos for CP problems with reduced time/space complexity.

Module 5: Problem Solving using Advanced Topics

CP Problem Solving using Advanced Topics: concept of disjoint sets and their efficient representation, algorithmic approaches such as Greedy, Backtracking, Dynamic Programming and applying them for CP problems using bottom-up dynamic programming.

List of Laboratory Tasks:

You are given the finishing times of 'N' runners in a marathon. Write a program to find the runner who finished in the third position. Focus: Basic data structures (arrays), sorting algorithms (e.g., insertion sort, selection sort), and basic input/output.

In the same marathon, you are given the finishing times of 'N' runners and their bib numbers. Write a program to efficiently find the top 10 runners and their corresponding bib numbers. Focus: Efficient sorting algorithms (e.g., merge sort, quick sort), data structures like priority queues, and optimizing for large datasets.

A library maintains a list of books with their unique IDs. Write a program to check if a given book ID is present in the library. Focus: Searching algorithms (linear search), basic data structures (arrays or lists).

The library wants to implement a system to quickly find books by their titles. Suggest an efficient data structure (e.g., a hash table or a trie) and explain how to implement it to achieve fast book lookups. Focus: Understanding the trade-offs between different data structures, choosing the most appropriate data structure for a specific problem, and implementing efficient search operations.

An online store sells products with different prices. Write a program to calculate the total cost of a given list of products. Focus: Basic arithmetic operations, working with arrays or lists to store product prices.

The online store offers discounts based on the total purchase amount. Design an algorithm to efficiently calculate the final cost of an order, considering different discount rules (e.g., percentage discounts, fixed amount discounts, tiered discounts). Focus: Algorithmic design, conditional statements, handling complex scenarios with multiple rules, and potentially using dynamic programming techniques for optimization.

You are given two integers, 'a' and 'm'. Calculate 'a' raised to the power 'm' modulo a large prime number 'p'. Focus: Basic modular arithmetic operations (modular exponentiation), understanding the modulo operator.

In a secure communication system, you need to efficiently compute the modular exponentiation for very large values of 'm'. Implement and analyze the efficiency of the binary exponentiation algorithm for this task. Focus: Efficient algorithms for modular exponentiation (binary exponentiation), time complexity analysis, and understanding the importance of efficient algorithms in cryptography.

You have a deck of 'N' cards. Calculate the total number of possible hands of size 'K' that can be drawn from the deck. Focus: Basic combinatorics (combinations), factorial calculations.

In a card game, you need to calculate the probability of drawing certain combinations of cards (e.g., a pair, a three-of-a-kind) from a shuffled deck. Design an efficient algorithm to calculate these probabilities. Focus: Advanced combinatorics (permutations and combinations with repetitions), probability calculations, and optimizing calculations to avoid overflows.

You are given a network of devices represented as a graph. Determine if there is a path between two given devices in the network. Focus: Graph traversal algorithms (depth-first search or breadth-first search).

In a secure network, you need to detect and isolate compromised devices. Design an algorithm that efficiently identifies devices that exhibit anomalous behavior (e.g., unusual traffic patterns) using XOR-based techniques for data comparison and pattern matching. Focus: Applying XOR operations for data comparison and pattern recognition, understanding the properties of XOR (e.g., commutative, associative), and designing algorithms for network anomaly detection.

You are given an array representing the speeds of cars on a highway. Find the minimum time required for all cars to pass a certain point. Focus: Basic array traversal, finding the minimum element in an array.

In a more realistic scenario, cars have different lengths. Implement a two-pointer approach to simulate the movement of cars and determine the minimum time for all cars to pass a given point. Focus: Two-pointer technique, simulating real-world scenarios with arrays, optimizing time complexity.

Given a string, find the number of occurrences of a specific substring within the string. Focus: Basic string manipulation, string matching (brute-force approach).

Implement the KMP (Knuth-Morris-Pratt) string matching algorithm to efficiently find all occurrences of a given pattern within a large text document. Focus: Advanced string matching algorithms, understanding the concept of the "next" array in KMP, optimizing for large input sizes.

An online auction platform receives bids for different items. Implement a data structure (e.g., a priority queue) to efficiently track the highest bid for each item. Focus: Priority queues, insertion and extraction operations on priority queues, basic implementation of a priority queue using an array or a suitable library.

The auction platform needs to handle a large number of bids concurrently. Design and implement a system that efficiently processes bids, updates the highest bid for each item, and handles potential race conditions. Focus: Concurrent data structures and algorithms, thread safety, handling race conditions, optimizing for high-throughput scenarios.

A social network can be represented as a graph where users are nodes, and connections between users are edges. Write an algorithm to find if two given users are connected in the network. Focus: Graph traversal algorithms (depth-first search or breadth-first search), basic graph representation (adjacency list or adjacency matrix).

In a large social network, efficiently finding the shortest path between two users is crucial. Implement Dijkstra's algorithm to find the shortest paths between users in the network, considering edge weights (e.g., representing the strength of connections). Focus: Shortest path algorithms (Dijkstra's algorithm), graph algorithms with weighted edges, optimizing for large graphs.

A file system can be modeled as a tree structure. Implement a function to traverse the file system and print the names of all files and directories. Focus: Tree traversal algorithms (depth-first search or breadth-first search), basic tree representation (using nodes and pointers).

Design and implement a file system that supports efficient operations like creating directories, deleting files, and finding files based on their names or paths. Consider using a combination of tree structures and hash tables for efficient indexing and searching. Focus: Designing and implementing file system structures, using multiple data structures together, optimizing for common file system operations.

An online shopping cart can be represented as a tree, where each node represents an item or a category of items. Write an algorithm to calculate the total price of all items in the shopping cart. Focus: Tree traversal, calculating sums within a tree structure.

Implement a system that allows customers to apply discounts and coupons to their shopping carts. Consider using a combination of trees and other data structures (e.g., hash tables) to efficiently apply discounts and calculate the final price. Focus: Applying discounts and promotions to tree-like structures, efficient implementation of discount rules, optimizing for complex pricing scenarios.

In a social network, users can form groups. Given a list of friendships, determine if all users in a specific group are connected (directly or indirectly) through friendships. Focus: Disjoint set union (DSU) data structure, basic connectivity checks.

Design an efficient algorithm to find the minimum number of new friendships needed to connect all users in the social network into a single, connected component. Focus: Applying DSU for finding connected components, greedy algorithms, optimization for minimizing connections.

A treasure hunt involves a series of clues leading to the final treasure. Given a list of possible paths and their associated costs, find the cheapest path to reach the treasure. Focus: Greedy algorithms (e.g., Dijkstra's algorithm for shortest paths), basic graph representation.

In a more complex treasure hunt, there are time constraints associated with each path. Design an algorithm to find the fastest path to the treasure while considering both path costs and time constraints.

Focus: Combining greedy approaches with other techniques (e.g., priority queues), handling multiple constraints, optimizing for time-critical scenarios.

In a simplified chess game with only rooks, determine the minimum number of moves required for a rook to reach a specific target square on an empty board. Focus: Breadth-first search (BFS) on a graph (the chessboard), basic graph traversal.

In a more realistic chess game with multiple pieces and obstacles, implement a minimax algorithm with alpha-beta pruning to determine the best move for a player. Focus: Game tree search, minimax algorithm, optimization techniques like alpha-beta pruning, handling complex game states.
Targeted Application & Tools that can be used: C or C++ Compiler (g++): The standard compiler for CP. Familiarize students with compilation flags (e.g., -O2 for optimization). IDE (Integrated Development Environment): Code:: Blocks, Visual Studio, CLion, or similar IDEs. These provide debugging capabilities, code completion, and other helpful features. Online Judges (CodeChef, Codeforces, LeetCode, HackerRank): Essential for practicing and submitting solutions. Debugger (gdb): Crucial for understanding code execution and finding bugs. Origin, excel and Mat lab soft wares for programming and data analysis. Number Theory Libraries: Some libraries provide pre-built functions for number theory operations (though often it's better to implement them yourself for learning). Wolfram Alpha: A useful tool for verifying number theory calculations and exploring concepts. String Libraries: Familiarize students with the string manipulation functions available in C++. Graph Visualization Tools: Tools like Graphviz can be helpful for visualizing graphs and understanding graph algorithms. DP Debugging Techniques: Practice debugging DP solutions, as they can be complex. Visualizing the DP table can be helpful.
Text Books: Guide to Competitive Programming: Learning and Improving Algorithms Through Contests" (3rd Edition), Antti Laaksonen, springer, 2024 "Data Structures and Algorithms in Java: A Project-Based Approach" – Dan S. Myers, Cambridge University Press Reference Books: Data Structures and Algorithmic Thinking with Python/C++/Java", Narasimha Karumanchi, 5th Edition, Career Monk, 2017. Introduction to Algorithms, Thomas H. Cormen (Author), Charles E. Leiserson (Author), Ronald L. Rivest , fourth edition April 2022 Web Resources

https://nptel.ac.in/courses/106106231
Project work/Assignment: Mention the Type of Project /Assignment proposed for this course
Assessment Type Midterm exam Assignment (review of digital/ e-resource from PU link given in references section - mandatory to submit screen shot accessing digital resource.) Quiz End Term Exam Self-Learning

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Course Code: APT4005	Course Title: Aptitude For Employability Type of Course: Practical Only	L- T-P- C	0	0	2	1

Version No.		1.0
Course Pre-requisites		Students should have the basic concepts of Quantitative aptitude, Verbal ability along with its applications in real life problems.
Anti-requisites		Nil
Course Description		This course is designed to enable the students to enhance their skills in quantitative aptitude and verbal ability skills.

Course Objective		The objective of the course is to familiarize the learners with concepts in Quantitative Aptitude and Verbal ability through problem solving techniques suitable for their career development.			
Course Outcomes		On successful completion of the course the students shall be able to: CO1] Recall all the basic mathematical concepts CO2] Identify the principle concept needed in a question CO3] Solve the quantitative and logical ability questions with the appropriate concept.			
Course Content:					
Module 1	Quantitative Ability	Lab-10hrs		Platform Assessment-10hrs	20 Hours
	Topics: Number System, Percentage, Ratio and Proportion, Average, Mixture and Allegation, Time and Work, Profit and Loss, Time Speed and Distance, Simple Interest and Compound Interest, Probability, Permutation and Combination.				
Module 2	Verbal Ability	Lab-5hrs		Platform Assessment-5hrs	10 Hours
	Topics: - Parts of Speech, Subject Verb Agreement, Spotting Error, Cloze Test, Verbal Analogies, Reading Comprehension, Idioms & Phrases, Para Jumbles				
	Targeted Application & Tools that can be used: Application area: Placement activities and Competitive examinations. Tools: LMS				
Evaluation	Continuous Evaluation Topic wise evaluation				

	Text Book Fast track objective by Rajesh Verma R S Aggarwal S.P Bakshi
	References www.indiabix.com www.testbook.com www.youtube.com/c/TheAptitudeGuy/videos
	Topics relevant to Skill development: Quantitative and reasoning aptitude for Skill Development through Problem solving Techniques. This is attained through assessment component mentioned in course handout.

Course Code: PPS 3018	Course Title: Preparedness for Interview Type of Course: Practical Only Course		L- T- P- C	0	0	2	1
Version No.		1.0					
Course Pre-requisites		Students are expected to understand Basic English. Students should have desire and enthusiasm to involve, participate and learn.					
Anti-requisites		NIL					

Course Description		This course is designed to enable students to understand soft skills concepts to be corporate ready. The modules are set to improve self-confidence, communicate effectively and Prepare for the Interview to assist in employability. It helps the students to get a glimpse of the acceptable corporate readiness and equip them with the fundamental necessities of being able to confidently deal with the highly competitive corporate environment and helps in crafting different types of resumes. The pedagogy used will be group discussions, flipped classrooms, continuous feedback, role-play and mentoring.		
Course Objective		The objective of the course is to familiarize the learners with the concepts of "Preparing for Interview" and attain SKILL DEVELOPMENT through PARTICIPATIVE LEARNING techniques.		
Course Out Comes		On successful completion of this course the students shall be able to: CO1: Develop professional Resumes CO2: Illustrate Resumes effectively CO3: Apply skills and knowledge learnt for active and effective Group Discussions and Interview		
Course Content:				
Module 1	Resume Building	Classroom activity		10 Hours
	Topics: Resume structure, use of templates, Do's and Don'ts, ATS methods, Cover Letter and Video Resume Activity: Real world scenarios			

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

Course Code: CSE7100	Course Title: Mini Project Type of Course:	L- T-P- C	0	0	0	4
Version No.	1.0					
Course Pre-requisites	Knowledge and Skills related to all the courses studied in previous semesters.					
Anti-requisites	NIL					
Course Description	Students observe science and technology in action, develop an awareness of the method of scientific experimentation, and often get an opportunity to see, study and operate sophisticated and costly equipment. They also learn about the implementation of the principles of management they have learnt in class, when they observe multidisciplinary teams of experts from engineering, science, economics, operations research, and management deal with techno-economic problems at the micro and macro levels. Finally, it enables them to develop and refine their language, communication and inter-personal skills, both by its very nature, and by the various evaluation components, such as seminar, group discussion, project report preparation, etc. The broad-based core education, strong in mathematics and science and rich in analytical tools, provides the foundation necessary for the student to understand properly the nature of real-life problems. The students have options to pursue this course as either Project Work and Dissertation at the university, or Project Work in an Industry/ Company/ Research Laboratory, or Internship Program in an Industry/Company.					
Course Objectives	The objective of the course is to familiarize the learners with the concepts of Professional Practice and attain Employability Skills through Experiential Learning techniques.					

Course Outcomes	On successful completion of this course the students shall be able to: Identify the engineering problems related to local, regional, national or global needs. (Understand) Apply appropriate techniques or modern tools for solving the intended problem. (Apply) Design the experiments as per the standards and specifications. (Analyze) Interpret the events and results for meaningful conclusions. (Evaluate) Appraise project findings and communicate effectively through scholarly publications. (Create)

Course Code: CSE7300	Course Title: Capstone Project Type of Course:	L- T-P- C	0	0	0	10
Version No.	1.0					
Course Pre-requisites	Knowledge and Skills related to all the courses studied in previous semesters.					
Anti-requisites	NIL					
Course Description	Students observe science and technology in action, develop an awareness of the method of scientific experimentation, and often get an opportunity to see, study and operate sophisticated and costly equipment. They also learn about the implementation of the principles of management they have learnt in class, when they observe multidisciplinary teams of experts from engineering, science, economics, operations research, and management deal with techno-economic problems at the micro and macro levels. Finally, it enables them to develop and refine their language, communication and inter-personal skills, both by its very nature, and by the various evaluation components, such as seminar, group discussion, project report preparation, etc. The broad-based core education, strong in mathematics and science and rich in analytical tools, provides the foundation necessary for the student to understand properly the nature of real-life problems. The students have options to pursue this course as either Project Work and Dissertation at the university, or Project Work in an Industry/ Company/ Research Laboratory, or Internship Program in an Industry/Company.					

Course Objectives	The objective of the course is to familiarize the learners with the concepts of Professional Practice and attain Employability Skills through Experiential Learning techniques.
Course Outcomes	On successful completion of this course the students shall be able to: Identify problems based on societal /research needs. (Understand) Apply Knowledge and skill to solve societal problems in a group. (Apply) Develop interpersonal skills to work as member of a group or leader. (Apply) Analyze the inferences from available results through theoretical / Experimental / Simulations. (Analyze) Analyze the impact of solutions in societal and environmental context for sustainable development. (Analyze) Improve in written and oral communication. (Create) Demonstrate capabilities of self-learning in a group, which leads to lifelong learning. (Understand)

Course Code: CAI3400	Course Title: Image Processing and Analysis Type of Course: Integrated	L- T-P- C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	CSE2264					
Anti-requisites	NIL					
Course Description	This course provides a solid foundation in the fundamentals and applications of image processing and analysis. Students will learn techniques for enhancing, segmenting, and interpreting digital images using various algorithms. It also covers essential image transformation and computer vision concepts relevant to real-world problems.					
Course Objective	To equip learners with the theoretical knowledge and practical skills in digital image processing techniques, enabling them to develop analytical solutions for computer vision problems.					

Course Outcomes	On successful completion of this course the students shall be able to: 1. Understand the basic concepts and techniques of image processing. (Understand) 2. Apply spatial and frequency domain operations to enhance images. (Apply) 3. Analyze images using segmentation, filtering, and transformation techniques. (Analyze) 4. Implement real-time image processing tasks using Python and OpenCV. (Apply)		
Course Content:			
Module 1	Introduction to Image Processing	Assignment 1	18[8L+10P] Sessions
Topics: Fundamentals of digital images, pixel operations, image acquisition, sampling and quantization, basic image transformations. Understanding image histograms and intensity transformations.			
Module 2	Image Enhancement and Restoration	Assignment 1	14[7L+7P] Sessions
Topics: Spatial domain techniques, histogram equalization, smoothing and sharpening filters. Noise models, restoration techniques, and Wiener filtering in the frequency domain.			
Module 3	Image Segmentation and Morphological Processing	Assignment 2	14[6L+8P] Sessions
Topics: Edge detection, thresholding, region growing and splitting. Morphological operations for shape analysis and binary image processing.			
Module 4	Image Analysis and Applications		14[6L+8P] Sessions
Topics: Feature extraction, texture analysis, object recognition. Applications in biomedical imaging, satellite imagery, and computer vision systems			
Project work/Assignment:			
Assignment 1 on (Module 1 and Module 2) Assignment 2 on (Module 3)			

List of Lab Tasks:

1. Perform basic image operations like read, write, and display using OpenCV.
2. Implement image enhancement using histogram equalization.
3. Apply various smoothing and sharpening filters to an image.
4. Convert color images to grayscale and binary formats.
5. Perform geometric transformations: rotation, scaling, and translation.
6. Add Gaussian, salt-and-pepper noise and apply noise removal filters.
7. Implement edge detection using Sobel, Prewitt, and Canny methods.
8. Segment an image using thresholding and region-based techniques.
9. Perform morphological operations: erosion, dilation, opening, and closing.
10. Extract features using contour detection and bounding boxes.
11. Analyze texture patterns using GLCM (Gray Level Co-occurrence Matrix).
12. Object detection using color segmentation and contour properties.
13. Image classification using histogram features and a simple classifier.
14. Real-time video processing using webcam and OpenCV.
15. Mini-project: Build an end-to-end image processing pipeline for a selected application.

REFERENCE MATERIALS:

TEXTBOOKS

1. Rafael C. Gonzalez and Richard E. Woods, “Digital Image Processing”, 4th Edition, Pearson Education, 2018.
2. Anil K. Jain, “Fundamentals of Digital Image Processing”, Prentice Hall, 1989.

REFERENCES

1. Bernd Jähne, “Digital Image Processing”, Springer, 2005.
2. Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis, and Machine Vision”, Cengage Learning, 2014.
3. Mark Nixon and Alberto Aguado, “Feature Extraction and Image Processing for Computer Vision”, Academic Press, 2019.

JOURNALS/MAGAZINES

1. IECE Journal of Image Analysis and Processing (JIAP):
2. Medical Image Analysis:
3. IPOL Journal (Image Processing On Line):

SWAYAM/NPTEL/MOOCs:

1. Digital Image Processing 2. Computer Vision and Image Processing – Fundamentals and Applications 3 Medical Image Analysis

Course Code: CAI3401	Course Title: Big Data Analytics for AI Type of Course: Integrated		L- T - P- C	2	0	2	3
Version No.	1.0						
Course Pre-requisites	CSE2264						
Anti-requisites	NIL						
Course Description	This course introduces students to the principles and technologies of big data analytics, with a particular emphasis on its role in AI systems. Students will learn how to process, store, and analyze massive volumes of data using distributed systems and scalable machine learning techniques. The course blends theoretical concepts with practical experience using industry-standard tools and platforms.						
Course Objective	The objective of the course is to familiarize the learners with the concepts of course Big Data Analytics for AI to attain SKILL DEVELOPMENT through EXPERIENTIAL LEARNING TECHNIQUES.						
Course Outcomes	On successful completion of the course the students shall be able to: CO1: Understand core concepts of big data and its intersection with AI. CO2: Gain hands-on experience with big data tools like Hadoop, Spark, and NoSQL databases. CO3: Build and optimize data pipelines and machine learning models at scale. CO4: Explore real-world AI applications driven by big data analytics.						
Course Content:							

Module 1	Introduction to Big Data and AI	Participative Learning			No. of Classes L-5 P-5
Introduction to Big Data and AI: Characteristics of Big Data (5Vs), Role of Big Data in AI applications, Overview of AI models driven by large-scale data Big Data Ecosystem and Architecture: Hadoop ecosystem overview, Spark vs. Hadoop, Lambda and Kappa architectures					
Module 2	Data Storage Systems	Participative Learning			No. of Classes L-5 P-5

Data Storage Systems: HDFS: Hadoop Distributed File System, NoSQL Databases: MongoDB, Cassandra, Data warehousing and lakes					
Module 3	Data Ingestion and Preprocessing	Experiential Learning			No. of Classes L-6 P-6
Data Ingestion and Preprocessing, ETL processes, Tools: Apache NiFi, Sqoop, Flume, Data cleaning and transformation techniques Distributed Computing with Hadoop and MapReduce, Hadoop architecture, Writing MapReduce jobs, Practical applications					
Module 4	Spark MLlib	Experiential Learning			No. of Classes L-7 P-6
Introduction to Apache Spark: Spark architecture and RDDs, Spark DataFrames and Datasets, Performance tuning basics Machine Learning with Spark MLlib, ML pipelines, Classification, regression, clustering, Model tuning and cross-validation					
List Of Laboratory Tasks:					

Lab 1: Introduction to Hadoop and HDFS

Objective: Understand the Hadoop architecture and HDFS storage system.

Tasks:

Set up a single-node Hadoop cluster.

Upload and retrieve files from HDFS.

Explore file distribution and block replication.

Lab 2: MapReduce Programming

Objective: Implement basic MapReduce jobs for large-scale data processing.

Tasks:

Write a word count MapReduce program in Java or Python.

Analyze performance and test on a large dataset.

Modify the job to perform sorting or filtering.

Lab 3: NoSQL Databases with MongoDB/Cassandra

Objective: Explore document-based and column-family NoSQL databases.

Tasks:

Install MongoDB/Cassandra.

Create collections and insert/query documents.

Perform analytics queries (aggregation, indexing, etc.).

Lab 4: Apache Spark Basics

Objective: Use Spark for distributed data processing.

Tasks:

Set up Apache Spark on local or cloud environment. Load and transform data using RDDs and DataFrames. Perform word count and basic transformations. Lab 5: Machine Learning with Spark Mllib Objective: Apply scalable ML models using Spark MLlib. Tasks: Use logistic regression and decision trees on large datasets. Build a pipeline for preprocessing and model training. Evaluate model accuracy using cross-validation.
Text Book(s)
"Big Data: Principles and Best Practices of Scalable Real-Time Data Systems" Author: Nathan Marz, James Warren Publisher: Manning Publications "Hadoop: The Definitive Guide" (4th Edition) Author: Tom White Publisher: O'Reilly Media "Learning Spark: Lightning-Fast Big Data Analysis" (2nd Edition) Authors: Jules S. Damji, Brooke Wenig, Tathagata Das, Denny Lee Publisher: O'Reilly Media
References:
"Spark: The Definitive Guide" Authors: Bill Chambers, Matei Zaharia Publisher: O'Reilly Media "Designing Data-Intensive Applications" Author: Martin Klepp mann Publisher: O'Reilly Media "Mining of Massive Datasets" (3rd Edition) Authors: Jure Leskovec, Anand Rajaraman, Jeff Ullman Publisher: Cambridge University Press "Practical Deep Learning for Cloud, Mobile, and Edge" Authors: Anirudh Koul, Siddha Ganju, Meher Kasam Publisher: O'Reilly Media
Topics relevant to SKILL DEVELOPMENT: Ethical decision-making in AI & data usage for Skill Development through Participative Learning techniques. This is attained through the Assignment/ Class Presentation/Group Discussion/Flipped Class as mentioned in the assessment component.

Course Code: CAI3402	Course Title: Optimization Techniques for Machine Learning Type of Course: Integrated	L- T- P- C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	CSE2264					
Anti-requisites	NIL					

<table>
<tr><td>Course Description</td><td colspan="4">This course introduces a range of machine learning models and optimization tools that are used to apply these models in practice. Course will introduce what lies behind the optimization tools often used as a black box as well as an understanding of the trade-offs of numerical accuracy and theoretical and empirical complexity.

For the students with some optimization background this course will introduce a variety of applications arising in machine learning and statistics as well as novel optimization methods targeting these applications.</td></tr>
<tr><td>Course Objective</td><td colspan="4">The objective of the course is to familiarize the learners with the concepts of Optimization Techniques for Machine Learning and attain Skill Development through Participative Learning techniques.</td></tr>
<tr><td>Course Outcomes</td><td colspan="4">On successful completion of this course the students shall be able to:

Describe fundamentals of Optimization Techniques [Remember].

Explain Optimization Techniques for Machine learning. [Understand].

Discuss Convex optimization models [Understand].

Apply Methods for convex optimization [Apply].</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1:</td><td>Optimization Basics</td><td>Quiz</td><td>Knowledge based Quiz</td><td>16[8L+8P]Sessions</td></tr>
<tr><td colspan="5">Topics: Introduction, The Basics of Optimization: Bivariate and Multivariate, Convex Objective Functions, Properties of Optimization in Machine Learning: Least-Square Classification, Support Vector Machines, Logistic Regression, Optimization Models for Binary Targets, Optimization Models for the Multiclass Setting, Coordinate Descent.</td></tr>
<tr><td>Module 2:</td><td>Optimization Solutions</td><td>Quiz</td><td>Comprehension based Quiz</td><td>15[8L+7P]Sessions</td></tr>
<tr><td colspan="5">Topics: Introduction, Challenges in Gradient-Based Optimization: Momentum-Based Learning, RMSProp, Newton Method, Newton Methods in Machine Learning: Computationally Efficient Variations of Newton Method, The Subgradient Method, Proximal Gradient Method, Non-differentiable Optimization Functions: Designing Surrogate Lose Functions.</td></tr>
<tr><td>Module 3</td><td>Constrained Optimization</td><td>Assignment</td><td>Batch-wise Assignments</td><td>14[7L+7P]Sessions</td></tr>
<tr><td colspan="5">Topics: Introduction, Primal Gradient Descent Methods: Primal Gradient Descent, Lagrangian Relaxation and Duality: Fundamentals of SVM Dual, Optimization Algorithms for the SVM Dual</td></tr>
<tr><td>Module 4:</td><td>Optimization in Computational Graphs</td><td>Assignment and Presentation</td><td>Batch-wise Assignment and Presentations</td><td>15[7L+8P]Sessions</td></tr>
<tr><td colspan="5">Topics: Introduction, basics, Optimization in Directed Acyclic Graphs: Optimizations in Directed Acyclic Graphs, Broad Framework, Application: Node-to-Node derivations using Brute Force</td></tr>
<tr><td colspan="5">Targeted Application & Tools that can be used: Use of Matlab tool</td></tr>
<tr><td colspan="5">Project work/Assignment:</td></tr>
</table>

Survey on Methods for convex optimization

Survey on Machine learning models related to optimization

Introduction to Optimization Problems using Python/Matlab.

Implement Bivariate and Multivariate Optimization.

Solve Least-Square Classification Problem.

Implement Support Vector Machine (SVM) Optimization.

Logistic Regression Model Optimization.

Coordinate Descent Algorithm Implementation.

Gradient Descent and Stochastic Gradient Descent Techniques.

Implement Momentum-based Gradient Descent.

RMSProp Optimization Method Application.

Newton Method Implementation for Machine Learning.

Subgradient Method for Non-differentiable Functions.

Proximal Gradient Method Implementation.

Solve Constrained Optimization Problems with Lagrangian Methods.

Optimization in Directed Acyclic Graphs.

Survey and Comparative Analysis of Optimization Algorithms.

Text Book

T1. Charu C. Aggarwal, " Linear Algebra and Optimization for Machine Learning", Springer, 2020.

T2. Sra Suvrit, Nowozin Sebastian, and Wright Stephen J, "Optimization for Machine Learning", The MIT Press,2012.

References

R1.Guanghui Lan, "First-order and Stochastic Optimization Methods for Machine Learning", Springer Cham, 2020.

Web References

W1. https://sm-nitk.vlabs.ac.in/

W2. https://nptel.ac.in/courses/

Topics relevant to SKILL DEVELOPMENT: Concepts of Convex optimization models and Methods for convex optimization for Skill Development through Problem Solving methodologies. This is attained through assessment component mentioned in course handout.

Course Code: CAI3403	Course Title: Deep Reinforcement Learning Type of Course: Integrated	L-T-P-C	2	0	2	3

<table>
<tr><td></td><td colspan="4"></td></tr>
<tr><td>Version No.</td><td colspan="4">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="4">CSE2264</td></tr>
<tr><td>Anti-requisites</td><td colspan="4">NIL</td></tr>
<tr><td>Course Description</td><td colspan="4">For both engineers and researchers in the field of Computer science, it is common to develop models of real-life situations and develop solutions based on those models. It is of utmost importance to come up with innovative solutions for scenarios that are highly stochastic. The objective of this course, is to introduce different reinforcement learning techniques which is a promising paradigm for stochastic decision making in the forthcoming era. Starting from the basics of stochastic processes, this course introduces several RL techniques that are as per the industry standard.

With a good knowledge in RL, the students will be able to develop efficient solutions for complex and challenging real-life problems that are highly stochastic in nature.</td></tr>
<tr><td>Course Objectives</td><td colspan="4">This course is designed to improve the learners 'EMPLOYABILITY SKILLS' by using EXPERIENTIAL LEARNING techniques.</td></tr>
<tr><td>Course Out Comes</td><td colspan="4">On successful completion of the course the students shall be able to:

1. Apply dynamic programming concepts to find an optimal policy in a gaming environment [Application]

2. Implement on-policy and off-policy Monte Carlo methods for finding an optimal policy in a

reinforcement learning environment. [Application]

3. Apply Temporal Difference learning techniques to the Frozen Lake RL environment [Application]

4. Apply various exploration-exploitation strategies of the Multi-Armed Bandit (MAB) problem[Application]</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>Introduction to Reinforcement Learning</td><td>Assignment</td><td>Programming using the OpenAI Gym environment</td><td>No. of Classes

L – 5 P – 6</td></tr>
<tr><td colspan="5">Topics : Elements of RL, Agent, environment Interface, Goals and rewards, RL platforms, Applications of RL, Markov decision process (MDP), RL environment as a MDP, Maths essentials of RL, Policy and its types, episodic and continuous tasks, return and discount factor, fundamental functions of RL – value and Q functions, model-based and model-free learning, types of RL environments, Solving MDP using Bellman Equation, Algorithms for optimal policy using Dynamic Programming -Value iteration and policy iteration, Example : Frozen Lake problem, Limitations and Scope</td></tr>
</table>

Module 2	Monte-Carlo(MC) methods	Assignment	Programming using the OpenAI Gym environment	No. of Classes L-5 P-6
Topics: Monte Carlo methods, prediction and control tasks, Monte Carlo prediction : algorithm, types of MC prediction, examples , incremental mean updates, Monte Carlo Control : algorithm, on-policy MC control, MC with epsilon-greedy policy, off-policy MC control. Limitations of MC method.				
Module 3	Temporal Difference(TD) Learning	Assignment/Quiz	Programming using the OpenAI Gym environment	No. of Classes L-7 P -6
Topics: Temporal difference learning: TD Prediction, TD Control : On-policy TD control – SARSA, computing the optimal policy using SARSA, Off-policy TD control – Q learning, computing optimal policy using Q learning, Examples, Difference between SARSA and Q-learning, Comparison of DP, MC and TD methods.				
Module 4	Multi-Armed Bandit (MAB) problem	Assignment	Programming using the OpenAI Gym environment	No. of Classes L-6 P -4
Topics: Understanding the MAB problem, Various exploration strategies – epsilon-greedy, softmax exploration, upper confidence bound and Thompson sampling, Applications of MAB - finding the best advertisement banner for a web site, Contextual bandits, introduction to Deep Reinforcement Learning(DRL) Algorithm – Deep Q Network (DQN)				

List of Lab Tasks:

1 .Software Setup :installalling Anaconda, OpenAI Gym and Universe.

Basic simulations of some gaming environments in Gym

2. Working with Gym environments to create agents with random policy

2.1 Create the Frozen Lake GYM environment and explore the states, action, transition probability, reward functions and generating episodes.

2.2 Create an agent for the Cart-Pole environment using a random policy and record the game

3. Finding the optimal policy for the agent using Dynamic Programming

3.1 Compute the optimal policy for the Frozen Lake Environment using value iteration method

3.2 Compute the optimal policy for the Frozen Lake Environment using policy iteration method

4. Implementing Monte Carlo prediction method using blackjack game

4.1 Every-visit MC prediction

4.2 First-visit MC prediction

5. Implementing on-policy MC control method using the epsilon-greedy policy for the blackjack game

6. Implementing Temporal Difference prediction for the Frozen lake environment for a random policy

7. Computing the optimal policy using on-policy TD control – SARSA

8. Computing the optimal policy using off-policy TD control – Q-learning

9. Multi-Armed Bandit problem 9.1 Creating a MAB in Gym 9.2 Compute the best arm using various exploration strategies such as epsilon-greedy and softmax exploration method. 10. Application of MAB – Finding the best advertisement banner for a web site using MAB
Targeted Application & Tools that can be used : Execution of the RL algorithms will be done using the environments provided by OpenAI's Gym and Gymnasium of Farama Foundation in "Colab", available at https://colab.research.google.com/ or Jupyter Notebook. Lab tasks will be implemented using the necessary libraries available in Python
Project work/Assignment: Mention the Type of Project /Assignment proposed for this course
Students can be given group assignments to develop different gaming environments and implement the RL algorithms
Text Book Richard S. Sutton and Andrew G. Barto, "Reinforcement Learning: An Introduction", MIT press, Second Edition, 2018. SudharshanRavichandiran, "Deep Reinforcement Learning with Python", Packt Publishers, Second Edition, 2020
References LaurraGraesser and Wan Loon Keng, "Foundations of Deep Reinforcement Learning", Pearson, 2022 https://www.udemy.com/course/artificial-intelligence-reinforcement-learning-in-python/

Course Code: CAI3404	Course Title: AI in Cyber Security Type of Course: Integrated	L- T-P- C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	CSE2264					
Anti-requisites	NIL					
Course Description	This course introduces students to the fundamentals of applying artificial intelligence techniques to cyber security. It covers threat detection, anomaly detection, malware classification, and the application of machine learning/deep					

<table>
<tr><td></td><td colspan="4">learning methods in securing data and systems. It includes hands-on lab exercises to help students build AI models for real-world cyber security challenges.</td></tr>
<tr><td>Course Objective</td><td colspan="4">This course is designed to improve learners' employability skills by applying experiential learning techniques in cybersecurity and artificial intelligence.</td></tr>
<tr><td>Course Outcomes</td><td colspan="4">On successful completion of this course the students shall be able to:
Apply AI techniques to detect and mitigate cyber threats.
Analyze network and system data to uncover anomalies.
Build intelligent systems to classify and predict malicious activity.
Use tools and frameworks to develop cyber security solutions using machine learning.</td></tr>
<tr><td colspan="5">Course Content:</td></tr>
<tr><td>Module 1</td><td>Introduction to AI in Cyber Security</td><td>Assignment</td><td></td><td>18[8L+10P]
Sessions</td></tr>
<tr><td colspan="5">Topics:
Fundamentals of Cyber Security: CIA Triad, Threats & Vulnerabilities, Role of Artificial Intelligence in Cyber Security, Cyber Attack Lifecycle and Defense Mechanisms, Overview of Machine Learning and Deep Learning Techniques, Introduction to Data Sources: Network logs, system logs, NetFlow, and packet capture data, Overview of Threat Intelligence Platforms (TIPs),
AI-based Cyber Security Use Cases in Industry, Challenges in Deploying AI for Cyber Defense (adversarial attacks, data imbalance, etc.).</td></tr>
<tr><td>Module 2</td><td>Anomaly and Intrusion Detection Systems</td><td>Assignment</td><td></td><td>14[7L+7P]
Sessions</td></tr>
<tr><td colspan="5">Topics:
Types of Intrusion Detection Systems (IDS): Signature-based vs. Anomaly-based, Dataset Exploration: KDDCup, NSL-KDD, CICIDS2017, Data Preprocessing: Feature Engineering, Label Encoding, Normalization, Supervised Learning for Intrusion Detection: SVM, Random Forest, Decision Trees, Unsupervised Learning: K-Means Clustering, Isolation Forests, Autoencoders,
Model Evaluation: Confusion Matrix, ROC Curve, Precision/Recall, Real-time Detection Systems with Streaming Data (e.g., using Kafka or PySpark), Case Study: Building and Deploying a ML-based IDS.</td></tr>
<tr><td>Module 3</td><td>Malware Detection and Classification</td><td>Assignment</td><td></td><td>14[6L+8P]
Sessions</td></tr>
<tr><td colspan="5">Topics:
Introduction to Malware Types: Virus, Worm, Trojan, Ransomware, Spyware, Static and Dynamic Malware Analysis Techniques, Feature Extraction: Opcode, API Call Sequences, Binary Analysis,
Deep Learning Techniques: CNN for image-based malware classification, RNN/LSTM for sequence learning, Model Training with Malimg and Microsoft Malware Dataset, Model Optimization Techniques</td></tr>
</table>

(Dropout, Early Stopping, Hyperparameter Tuning), Use of Embeddings for Malware Behavior Analysis, Adversarial Examples and Evasion Techniques in Malware Detection.

Module 4	AI for Cyber Threat Intelligence and Response			

Threat Intelligence Fundamentals and Sources (OSINT, commercial feeds), Natural Language Processing for Cyber Threat Intelligence (CTI) extraction, Entity Recognition and Classification from Threat Reports, URL and Email Phishing Detection using ML/NLP, Behavioral Biometrics: Keystroke Dynamics, Mouse Movement Analysis, Deep Learning for Security Information and Event Management (SIEM), AI in Incident Response and Automation (SOAR platforms),

Case Study: Detecting phishing websites using NLP and ensemble models.

Project work/Assignment:

Assignment 1: Threat Detection using Supervised Learning

Assignment 2: Malware Classification using Deep Learning

Mini Project (Team-based): AI-Driven Cyber Threat Intelligence Dashboard

Lab 1: Explore Python libraries for cyber security (Scikit-learn, TensorFlow, Keras, Pandas).

Lab 2: Data preprocessing and feature extraction from KDD Cup dataset.

Lab 3: Develop a basic binary classifier to detect malicious network traffic.

Lab 4: Implement an SVM model for intrusion detection.

Lab 5: Build a deep neural network to classify attacks using NSL-KDD dataset.

Lab 6: Train an autoencoder for anomaly detection in log files.

Lab 7: Use Random Forest for malware classification.

Lab 8: Text mining of phishing emails using NLP.

Lab 9: Create a spam classifier using Naïve Bayes.

Lab 10: Train an LSTM model for real-time anomaly detection.

Lab 11: Visualize threat patterns using t-SNE and PCA.

Lab 12: Use a GAN to generate synthetic attack data.

Lab 13: Build a model for phishing URL detection.

Lab 14: Implement behavioral biometrics using keystroke dynamics.

Lab 15: Develop a dashboard integrating AI-driven threat alerts.

REFERENCE MATERIALS:

TEXTBOOKS

Mark Stamp, Introduction to Machine Learning with Applications in Information Security, CRC Press, 2020.

Clarence Chio, David Freeman, Machine Learning and Security: Protecting Systems with Data and Algorithms, O'Reilly, 2018.

REFERENCES Xiaofeng Chen, Cyber Security: AI and Big Data Perspective, Springer, 2021. Sumeet Dua, Xian Du, Data Mining and Machine Learning in Cybersecurity, CRC Press, 2011. Richard E. Smith, Elementary Information Security, Jones & Bartlett Learning, 2021. JOURNALS/MAGAZINES IEEE Transactions on Information Forensics and Security https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=8858 Covers the theory and practice of information forensics, cyber defense, and security. ACM Transactions on Privacy and Security (TOPS) https://dl.acm.org/journal/tops Peer-reviewed research on cyber security systems, privacy-preserving AI, and secure protocols. Computers & Security (Elsevier) https://www.sciencedirect.com/journal/computers-and-security Practical and academic articles on cyber threats, security analytics, and AI applications in security. Journal of Cybersecurity (Oxford Academic) https://academic.oup.com/cybersecurity Multidisciplinary research on digital threats and AI-driven defensive mechanisms. IEEE Security & Privacy Magazine https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=8013 Blends academic depth with industry relevance; covers AI, forensics, and emerging cyber threats. Cybersecurity Magazine https://cybersecurity-magazine.com Regularly features expert opinion, trends, and technologies including AI in cyber security. SWAYAM/NPTEL/MOOCs: NPTEL – Introduction to Machine Learning (IIT Kharagpur) https://onlinecourses.nptel.ac.in/noc22-cs58 AI for Cybersecurity Specialization – IBM https://www.coursera.org/specializations/ai-cybersecurity Covers: AI and ML techniques to detect malware, phishing, and threats in network traffic. Hands-on labs included. ☐

Course Code: CAI3405	Course Title: Explainable AI Type of Course: Integrated	L- T-P- C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	CSE2264					

Anti-requisites	NIL			
Course Description	This course introduces the concepts, techniques, and challenges of Explainable Artificial Intelligence (XAI). Students will learn to build interpretable models and apply explainability tools to demystify complex AI decisions, making AI systems transparent, trustworthy, and accountable. Emphasis will be on practical implementation and evaluation using real-world datasets.			
Course Objective	1 Understand the need for and principles of explainable AI 2 Explore techniques for explaining model predictions 3 Gain hands-on experience with state-of-the-art XAI tools and libraries 4 Build models that are interpretable and meet regulatory or ethical standards			
Course Outcomes	On successful completion of this course the students shall be able to: Explain the importance and scope of explainability in AI Compare interpretable models with black-box models Apply XAI techniques (e.g., LIME, SHAP) to real-world datasets Develop systems with enhanced transparency and traceability Evaluate explainability metrics and their impact on model trustworthiness			
Course Content:				
Module 1	Introduction to Explainable AI	Understand		13[7L+4P] Sessions
Topics: What is Explainability? Why it matters, Challenges in interpreting ML/DL models AI Ethics and Responsible AI				
Module 2	Interpretable Models vs. Black-box Models	Apply		14[7L+7P] Sessions
Topics: Decision Trees, Linear Models, Rule-based Models, Black-box models: Neural Networks, Ensemble methods, Trade-offs between accuracy and explainability				
Module 3	Post-Hoc Explanation Techniques	Assignment		14[6L+8P] Sessions
Topics: Local vs. Global explanations, LIME (Local Interpretable Model-Agnostic Explanations), SHAP (SHapley Additive exPlanations), Partial Dependence Plots, Feature Importance				

Module 4	Visual and Textual Explanations	Assignment	14[6L+8P] Sessions

Saliency maps for CNNs,

Attention mechanisms in NLP,

Counterfactual and contrastive explanations

Project work/Assignment:

Assignment 1 on (Module 1 and Module 2)

Assignment 2 on (Module 3)

List of Lab Tasks:

Lab 1 – Compare interpretable vs. black-box models

Lab 2 – Implement LIME for image/text classification

Lab 3 – Apply SHAP to a random forest classifier

Lab 4 – Visualize CNN saliency maps for image predictions

Lab 5 – Use What-If Tool (TensorBoard) for exploring model fairness

Lab 6 – Build a decision support tool using explainable outputs

Lab 7 – Case Study: Explainability in credit scoring models

Lab 8 – Final Project: Explainable AI dashboard for real-world data

REFERENCE MATERIALS:

TEXTBOOKS

☐ Christoph Molnar – Interpretable Machine Learning, 2022 Edition (Free online)

☐ Sameer Singh et al. – Explainable AI: A Guide for Practitioners

☐ Gunning & Aha – DARPA's XAI Program Publications

REFERENCES

IEEE XAI publications

Research papers from NeurIPS, ICML, and ACL on XAI

XAI Fairness & Bias Toolkits by Google, IBM, and Microsoft

JOURNALS/MAGAZINES

IEEE Transactions on Artificial Intelligence

Journal of Artificial Intelligence Research (JAIR)

ACM Transactions on Intelligent Systems and Technology (TIST)

Artificial Intelligence Journal (Elsevier)

SWAYAM/NPTEL/MOOCs:

NPTEL: Responsible AI by IIT Madras Coursera: Explainable AI with Google Cloud FastAI: Modules on Model Interpretation IBM AI Explainability 360 Toolkit

Course Code: CAI3406	Course Title: Responsible AI Type of Course: Integrated	L- T-P- C	2	0	2	3
Version No.		1.0				
Course Pre-requisites		CSE2264				
Anti-requisites		NIL				
Course Description		Responsible AI emphasizes transparency and explainability, ensuring that AI-driven decisions are understandable and justifiable. It also prioritizes security, reliability, and sustainability, aiming to create AI systems that are safe, efficient, and environmentally conscious. Ultimately, Responsible AI seeks to align technology with human values, promoting trust and ensuring that AI enhances rather than harms society.				
Course Objective		The objective of Responsible AI is to develop and deploy artificial intelligence in a way that is ethical, fair, transparent, and aligned with human values.				
Course Out Comes		On successful completion of this course the students shall be able to: To state aspects of responsible AI such as fairness, accountability, bias, privacy etc.[Remember] To assess the fairness and ethics of AI models.[Understand] To enforce fairness in models and remove bias in data.[Understand] To preserve the privacy of individuals while learning from them and apply it to various domains.[Apply]				
Course Content:						

Module 1	Introduction to Responsive AI (Remember)	Assignment			11 Sessions
	Topics: Artificial Intelligence Fundamentals, definition of responsible AI, Importance of responsible AI, core principles of responsible AI, Regulations and Policies, challenges, Responsible AI in practice.				
Module 2	Fairness and Bias (Understand)	Assignment			11 Sessions
	Topics:				

	Sources of Biases, Exploratory data analysis, limitation of a dataset, Preprocessing, in processing and postprocessing to remove bias, Group fairness and Individual fairness, Counterfactual fairness					
Module 3		Interpretability and explainability, Ethics and Accountability (Understand)	Assignment			12 sessions
	Topics: Interpretability through simplification and visualization, Intrinsic interpretable methods Post Hoc interpretability, Explainability through causality, Model agnostic Interpretation, Auditing AI models, fairness assessment, Principles for ethical practices					
Module 4		Privacy preservation (Apply)	Assignment			11 sessions
	Topics: Attack models, Privacy-preserving Learning, Differential privacy, Federated learning, Case Study- Recommendation systems, Medical diagnosis, Hiring/ Education, Computer Vision, Natural Language Processing					
	Lab Experiments: Lab 1 – Real-time sentiment analysis from live social media feed Lab 2 – Build an AI-powered chatbot using Dialogflow or Rasa Lab 3 – Create a user-adaptive recommendation engine Lab 4 – Implement online learning for a dynamic classification problem Lab 5 – Emotion recognition from facial expressions using webcam input Lab 6 – Deploy a low-latency AI model using TensorFlow Lite Lab 7 – Build a real-time fraud detection prototype using streaming data Lab 8 – Mini Project: End-to-end responsive AI application					
	Targeted Application & Tools that can be used: ChatGPT, DeepSeek					
	Project work/Assignment: Mention the Type of Project /Assignment proposed for this course					
	Case Study in different domains					
	Text Book Virginia Dignum, "Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way" Springer Nature, 04-Nov-2019;ISBN-10 : 3030303705, ISBN-13 : 978-3030303709 Christoph Molnar "Interpretable Machine Learning".Lulu, 1st edition, March 24, 2019; eBook. ISBN-10 : 0244768528, ISBN-13 : 978-0244768522 [available online]					

	References R1. Voeneky S, Kellmeyer P, Mueller O, Burgard W, eds. The Cambridge Handbook of Responsible Artificial Intelligence. In: The Cambridge Handbook of Responsible Artificial Intelligence: Interdisciplinary Perspectives. Cambridge Law Handbooks. Cambridge University Press; 2022:i-ii. Web links W1. Responsible AI for generative models: Designing for responsibility W2. Responsible AI W3. Microsoft Responsible AI - Fairness
	Topics relevant to development of "Employability": Responsible AI ethics, Fairness and Bias, ethics and accountability

Course Code: CAI3407	Course Title: Agentic AI Type of Course: Integrated	L- T-P- C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	CSE2264					
Anti-requisites	NIL					
Course Description	This course provides a comprehensive introduction to *Agentic AI*, focusing on building autonomous, tool-using systems powered by Large Language Models (LLMs). Students will explore the foundations of multi-step LLM workflows, prompt engineering, and asynchronous execution while gaining hands-on experience with leading frameworks like OpenAI API, CrewAI, LangGraph, and AutoGen. Through modules on multi-agent collaboration, graph-based agent design, and model context protocols, the course emphasizes practical skills in designing, orchestrating, and deploying intelligent agents capable of communication, memory management, and decision-making. Real-world case studies across domains such as robotics, finance, and smart cities will illustrate the transformative potential of agentic systems.					
Course Objective	1. Introduce the concept of Agentic AI and equip students with the foundational knowledge of LLM-based agent workflows. 2. Develop practical skills in designing and deploying single-agent and multi-agent systems using modern frameworks such as OpenAI API, CrewAI, LangGraph, and AutoGen. 3. Explore orchestration techniques, communication models, and collaboration strategies among intelligent agents. 4. Enable students to build graph-based workflows and memory-augmented agents for solving real-world problems. 5. Familiarize students with context-aware protocol design using Model Context Protocol (MCP) for structured and scalable agent communication.					
Course Outcomes	On successful completion of this course the students shall be able to:					

	CO1: Explain the core concepts of Agentic AI, including agent workflows, prompt engineering, and LLM function execution. **CO2**: Use OpenAI APIs and asynchronous Python to build simple autonomous agentic systems after configuring the development environment. **CO3**: Design multi-agent workflows using CrewAI with task coordination, memory, and collaboration strategies. **CO4**: Construct graph-based agent workflows using LangGraph, leveraging state machines, reducers, and checkpointing. **CO5**: Manage agent messaging protocols using AutoGen and Model Context Protocol (MCP). **CO6**: Apply agentic AI systems to real-world domains such as robotics, finance, and smart infrastructure through case studies.			
Course Content:				
Module 1	Introduction to Agentic AI and Foundations of LLM Workflows	Assignment		16[8L+8P] Sessions
Concept of Agentic AI & Multi-step LLM workflows, Building your first agentic system using OpenAI API, Setting up environments (Windows/Mac, Git, Cursor IDE, APIs), Prompt engineering for tool-based autonomy, Agent vs workflow patterns, Async Python and LLM function calling, Tool use and function execution in LLMs, Sequential and parallel processing in agentic workflows				
Module 2	Multi-Agent Workflows and LLM Orchestration	Assignment		16[8L+8P] Sessions
Designing with CrewAI: Agents, tasks, tools, processes, crews, memory, building a web search tool; Multi-agent: Architectures, Designing a Multi Agent Structure with Message Passing, Modes of Collaboration Among AI Agents, communication and collaboration, Case Studies: Robotics, Finance, Smart Cities and Energy Grids, Pydantic AI: Introduction, Creating Simple Agent, Building agent with personas, goals, and dynamic memory.				
Module 3	Graph-Based Agent Design with LangGraph	Assignment		16[8L+8P] Sessions
LangGraph architecture and components, State machines: Nodes, edges, reducers, Workflow graphs and supersteps, Checkpointing and persistent memory, Web automation with Playwright + LangGraph, Structured outputs and feedback loops, LangChain tool integration				
Module 4	AutoGen and Model Context Protocol (MCP)	Assignment		12[6L+6P] Sessions
AutoGen : agents, messaging, single agent, multiple agent. MCP: Introduction, Architecture, context fragmentation, clients, servers and protocol.				
Project work/Assignment:				
Assignment 1 on (Module 1 and Module 2) Assignment 2 on (Module 3)				
List of Lab Tasks: Lab 1: Setting Up the Agentic AI Development Environment Objective: Install and configure required tools for agentic system development. Task: Set up Python, Git, OpenAI API key, Cursor IDE, and environment variables. Activity: Perform a guided installation and validate API access with a basic GPT query.				

Lab 2: First Agentic System using OpenAI API
Objective: Understand LLM workflows through simple agent design.
Task: Build a basic Python agent that takes user input and responds using GPT-4.
Activity: Implement asynchronous function calling and test multiple prompts.

Lab 3: Prompt Engineering for Tool Use
Objective: Design effective prompts for LLMs to interact with tools.
Task: Create prompt templates for a calculator, summarizer, and code explainer tools.
Activity: Compare output quality with different prompting strategies.

Lab 4: Agent vs Workflow Pattern
Objective: Distinguish between agent-based and workflow-based models.
Task: Implement both an agent and a predefined workflow for a document summarizer.
Activity: Analyze performance and flexibility trade-offs.

Lab 5: Building a Multi-Agent CrewAI System
Objective: Learn to coordinate multiple agents in a single task.
Task: Design a system with researcher, summarizer, and presenter agents.
Activity: Use CrewAI to assign roles, tools, and memory, then simulate a research task.

Lab 6: Case Study – Multi-Agent System for Web Search
Objective: Apply multi-agent collaboration to a real-world problem.
Task: Implement a system that searches the web and compiles a report.
Activity: Assign different sub-tasks to agents and use memory for tracking.

Lab 7: Building an Agent with Persona and Goals using Pydantic AI
Objective: Customize agent behavior using metadata.
Task: Create an agent with a defined personality, goals, and memory.
Activity: Use Pydantic schemas to enforce structure and simulate goal-seeking behavior.

Lab 8: LangGraph Basics – Nodes and Edges
Objective: Design workflows as state machines.
Task: Build a LangGraph with nodes for input, processing, and output.
Activity: Visualize the graph and simulate input-output flows.

Lab 9: Checkpointing and Feedback Loops in LangGraph
Objective: Implement persistent memory and iterative feedback.
Task: Add checkpoint nodes and feedback validation in LangGraph.
Activity: Re-run tasks based on user feedback or system failure.

Lab 10: Web Automation using LangGraph + Playwright
Objective: Enable agents to perform automated web tasks.
Task: Build an agent that logs into a site and extracts content.
Activity: Integrate Playwright actions into LangGraph nodes.

Lab 11: Building AutoGen Agents with Messaging
Objective: Explore agent communication and message passing.
Task: Create single-agent and multi-agent setups using AutoGen.
Activity: Simulate collaborative planning via structured messaging.

Lab 12: Model Context Protocol (MCP) – Context Fragmentation
Objective: Handle large context and multi-client coordination.
Task: Build an agent system using MCP to divide and manage context fragments.
Activity: Simulate a client-server model and trace message flows.

REFERENCE MATERIALS:
TEXTBOOKS
Building Agentic AI Systems, Anjanava Biswas Wrick Talukdar, 2025 Packt Publishing

REFERENCES Michael Wooldridge, An Introduction to MultiAgent Systems, 2nd Ed AI research papers from IJCAI, AAAI, AAMAS OpenAI research on agentic models and autonomous systems Case studies on autonomous robotics and virtual agent behavior JOURNALS/MAGAZINES Autonomous Agents and Multi-Agent Systems (Springer) Journal of Artificial Intelligence Research (JAIR) Artificial Intelligence Journal (Elsevier) IEEE Transactions on Cognitive and Developmental Systems SWAYAM/NPTEL/MOOCs: NPTEL: Artificial Intelligence – Search Methods for Problem Solving Coursera: Autonomous Agents – University of Alberta edX: Multi-Agent Systems and Distributed AI OpenAI Blog: Research articles on emerging agentic models (e.g., AutoGPT)

Course Code: CAI3407	Course Title: Agentic AI Type of Course: Integrated	L- T-P- C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	CSE2264					
Anti-requisites	NIL					
Course Description	This course provides a comprehensive introduction to *Agentic AI*, focusing on building autonomous, tool-using systems powered by Large Language Models (LLMs). Students will explore the foundations of multi-step LLM workflows, prompt engineering, and asynchronous execution while gaining hands-on experience with leading frameworks like OpenAI API, CrewAI, LangGraph, and AutoGen. Through modules on multi-agent collaboration, graph-based agent design, and model context protocols, the course emphasizes practical skills in designing, orchestrating, and deploying intelligent agents capable of communication, memory management, and decision-making. Real-world case studies across domains such as robotics, finance, and smart cities will illustrate the transformative potential of agentic systems.					
Course Objective	1. Introduce the concept of Agentic AI and equip students with the foundational knowledge of LLM-based agent workflows. 2. Develop practical skills in designing and deploying single-agent and multi-agent systems using modern frameworks such as OpenAI API, CrewAI, LangGraph, and AutoGen. 3. Explore orchestration techniques, communication models, and collaboration strategies among intelligent agents. 4. Enable students to build graph-based workflows and memory-augmented agents for solving real-world problems. 5. Familiarize students with context-aware protocol design using Model Context Protocol (MCP) for structured and scalable agent communication.					
Course Outcomes	On successful completion of this course the students shall be able to: **CO1**: Explain the core concepts of Agentic AI, including agent workflows, prompt engineering, and LLM function execution.					

	CO2: Use OpenAI APIs and asynchronous Python to build simple autonomous agentic systems after configuring the development environment. **CO3**: Design multi-agent workflows using CrewAI with task coordination, memory, and collaboration strategies. **CO4**: Construct graph-based agent workflows using LangGraph, leveraging state machines, reducers, and checkpointing. **CO5**: Manage agent messaging protocols using AutoGen and Model Context Protocol (MCP). **CO6**: Apply agentic AI systems to real-world domains such as robotics, finance, and smart infrastructure through case studies.

Course Content:

Module 1	Introduction to Agentic AI and Foundations of LLM Workflows	Assignment		16[8L+8P] Sessions

Concept of Agentic AI & Multi-step LLM workflows, Building your first agentic system using OpenAI API, Setting up environments (Windows/Mac, Git, Cursor IDE, APIs), Prompt engineering for tool-based autonomy, Agent vs workflow patterns, Async Python and LLM function calling, Tool use and function execution in LLMs, Sequential and parallel processing in agentic workflows

Module 2	Multi-Agent Workflows and LLM Orchestration	Assignment		16[8L+8P] Sessions

Designing with CrewAI: Agents, tasks, tools, processes, crews, memory, building a web search tool; Multi-agent: Architectures, Designing a Multi Agent Structure with Message Passing, Modes of Collaboration Among AI Agents, communication and collaboration, Case Studies: Robotics, Finance, Smart Cities and Energy Grids, Pydantic AI: Introduction, Creating Simple Agent, Building agent with personas, goals, and dynamic memory.

Module 3	Graph-Based Agent Design with LangGraph	Assignment		16[8L+8P] Sessions

LangGraph architecture and components, State machines: Nodes, edges, reducers, Workflow graphs and supersteps, Checkpointing and persistent memory, Web automation with Playwright + LangGraph, Structured outputs and feedback loops, LangChain tool integration

Module 4	AutoGen and Model Context Protocol (MCP)	Assignment		12[6L+6P] Sessions

AutoGen : agents, messaging, single agent, multiple agent. MCP: Introduction, Architecture, context fragmentation, clients, servers and protocol.

Project work/Assignment:

Assignment 1 on (Module 1 and Module 2)
Assignment 2 on (Module 3)

List of Lab Tasks:

Lab 1: Setting Up the Agentic AI Development Environment
Objective: Install and configure required tools for agentic system development.
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Objective: Customize agent behavior using metadata.
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Activity: Simulate collaborative planning via structured messaging.

Lab 12: Model Context Protocol (MCP) – Context Fragmentation
Objective: Handle large context and multi-client coordination.
Task: Build an agent system using MCP to divide and manage context fragments.
Activity: Simulate a client-server model and trace message flows.

REFERENCE MATERIALS:
TEXTBOOKS
Building Agentic AI Systems, Anjanava Biswas Wrick Talukdar, 2025 Packt Publishing
REFERENCES
Michael Wooldridge, An Introduction to MultiAgent Systems, 2nd Ed

AI research papers from IJCAI, AAAI, AAMAS OpenAI research on agentic models and autonomous systems Case studies on autonomous robotics and virtual agent behavior JOURNALS/MAGAZINES Autonomous Agents and Multi-Agent Systems (Springer) Journal of Artificial Intelligence Research (JAIR) Artificial Intelligence Journal (Elsevier) IEEE Transactions on Cognitive and Developmental Systems SWAYAM/NPTEL/MOOCs: NPTEL: Artificial Intelligence – Search Methods for Problem Solving Coursera: Autonomous Agents – University of Alberta edX: Multi-Agent Systems and Distributed AI OpenAI Blog: Research articles on emerging agentic models (e.g., AutoGPT)

Course Code: CAI3408	Course Title: Deep Neural Networks Type of Course: Integrated		L- T-P- C	2	0	2	3
Version No.	1.0						
Course Pre-requisites	CSE2264						
Anti-requisites	NIL						
Course Description	This course introduces students to the concepts of deep neural networks and state of the art approaches to develop deep learning models. In this course students will be given an exposure to the details of neural networks as well as deep learning architectures and to develop end-to-end models for such tasks. It will help to design and develop an application-specific deep learning models and also provide the practical knowledge handling and analyzing end user realistic applications. Topics include Fundamental concepts of deep neural networks, Convolutional Neural Networks, Recurrent Network structures, Deep Unsupervised Learning, Generative Adversarial Networks and applications in various problem domains.						
Course Objective	This course is designed to improve the learners EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques.						
Course Outcomes	On successful completion of this course the students shall be able to: CO1: Explain the fundamentals of Neural Network. CO2: Apply Unsupervised Learning Networks for feature extraction. CO3: Apply CNN and its variants for suitable applications. CO4: Apply Recurrent Neural Network for their suitable applications.						
Course Content:							
Module 1	INTRODUCTION	Assignment			16[8L+8P] Sessions		

<table>
<tr><td colspan="5">Topics:

Fundamentals of Neural Networks: Model of Artificial Neuron and Biological Neuron, Learning rules and various activation functions. Single layer Feed-forward networks. Multilayer Feed-forward networks. Back Propagation networks, Early Stopping, Bagging and Dropout - batch normalization, Regularization.</td></tr>
<tr><td>Module 2</td><td>UNSUPERVISED LEARNING NETWORKS</td><td>Assignment</td><td></td><td>16[8L+8P]

Sessions</td></tr>
<tr><td colspan="5">Topics:

Training Algorithms for Pattern Association-Auto associative Memory Network-Hetero associative Memory Network-Bidirectional Associative Memory (BAM)-Hopfield Networks- -Kohonen Self-Organizing Feature Maps-Learning Vector Quantization-Radial, Autoencoders, Boltzmann Machine, Generalized Adversarial Network.</td></tr>
<tr><td>Module 3</td><td>CONVOLUTIONAL NEURAL NETWORKS</td><td>Assignment</td><td></td><td>16[8L+8P]

Sessions</td></tr>
<tr><td colspan="5">Topics:

Convolutional Neural Networks-Deep Learning Neural Networks-Extreme Learning Machine Model-Convolutional Neural Networks: The Convolution Operation – Motivation – Pooling – Variants of the basic Convolution Function – Applications: Computer Vision, Image Generation, Image Compression.</td></tr>
<tr><td>Module-4</td><td>RECURRENT NEURAL NETWORKS</td><td>Assignment</td><td></td><td>12[6L+6P]

Sessions</td></tr>
<tr><td colspan="5">Recurrent Neural Networks (RNN), Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU), Deep Recurrent Networks, Applications: Image Generation, Image Compression, Natural Language Processing.</td></tr>
<tr><td colspan="5">Project work/Assignment:</td></tr>
<tr><td colspan="5">Assignment 1 on (Module 1 and Module 2)

Assignment 2 on (Module 3 and Module 4)</td></tr>
<tr><td colspan="5">List of Laboratory Tasks:

Lab 1: Working with Deep Learning Frameworks

Objective: Explore various Deep Learning Frameworks

Tasks: Identify deep learning frameworks (Keras, Tensorflow, Matplotlib, etc)

Activity: Practice with various methods available in DL Frameworks to develop a Model.

Lab 2: Build a Basic Artificial Neural Network

Objective: Create a ANN with DL frameworks.

Task: Identify suitable ANN Layers using Keras and Tensorflow.</td></tr>
</table>

Activity: Design a basic Artificial Neural Networks using Keras with TensorFlow (pima-indians-diabetes)

Lab 3 and Lab 4: Build a Multi-Layer Feed Forward Network

Objective: Create a Multi-Layer Feed Forward Network for classification task.

Task: Identify suitable model for house price prediction.

Activity: Design a Multi-Layer Feed Forward Network for implementing classification and fine-tuning using House price.csv

Lab 5: Build an Auto-Encoder model

Objective: Create an Unsupervised Deep Learning Model.

Task: Create AutoEncoder network Output Translations.

Activity: implement an Encoder-Decoder Recurrent neural network model for Neural Machine Translation.

Lab 6: Build Generative Adversarial Networks.

Objective: Create an Unsupervised Deep Learning Model.

Task: Design GAN Architecture for Image generations.

Activity: Design a Age Prediction model by Applying Generative Adversarial

Lab 7: Build a Convolutional Neural Network

Objective: Create a CNN model.

Task: Build CNN architecture for Dog-Cat classification problem.

Activity: Implement a Convolution Neural Network (CNN) for dog/cat classification problem using keras

Lab 8 and Lab 9: Build a Time-Series Model

Objective: Create a RNN and LSTM Model

Task: Build RNN/LSTM Model for predicting time series data.

Activity Train a sentiment analysis model on IMDB dataset, use RNN layers with LSTM/GRU notes

Lab 10: Build a Gated Recurrent Unit architecture.

Objective: Create a Time Series Model.

Task: Build GRU Architecture for predicting time series data.

Activity: Implement a GRU architecture for language translations.

Lab 11 and Lab 12: Build a Transfer Learning Model.

Objective: Create a Seq2Seq Model

Task: Create Hugging-face API using Transfer learning model.

Activity: Implement Transfer Learning models for classification problems Exploring Hugging-face API

REFERENCE MATERIALS:

TEXT BOOKS:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2017.

2. Francois Chollet, "Deep Learning with Python", Second Edition, Manning Publications, 2021. 106

REFERENCES:

1. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn and TensorFlow", Oreilly, 2018.

2. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017.

3. Charu C. Aggarwal, "Neural Networks and Deep Learning: A Textbook", Springer International Publishing, 1st Edition, 2018.

4. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018

5. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020

6. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017.

7. S Rajasekaran, G A Vijayalakshmi Pai, "Neural Networks, FuzzyLogic and Genetic Algorithm, Synthesis and Applications", PHI Learning, 2017.

8. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017

9. James A Freeman, David M S Kapura, "Neural Networks Algorithms, Applications, and Programming Techniques", Addison Wesley, 2003.

JOURNALS/MAGAZINES

IEEE Transactions on Neural Networks and Learning Systems

https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=5962385

IEEE Transactions on Pattern Analysis and Machine Intelligence

https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=34http://ijaerd.com/papers/special_papers/IT032.pdf

International Journal of Intelligent Systems https://onlinelibrary.wiley.com/journal/1098111x

SWAYAM/NPTEL/MOOCs:

Swayam Nptel – Deep Learning – IIT Ropar https://onlinecourses.nptel.ac.in/noc21_cs35/preview

Coursera – Neural Networks and Deep Learning Andrew Ng

Coursera - Neural Networks for Machine Learning by Geoffrey Hinton in Coursera

<table>
<tr><td>Course Code: CAI3409</td><td colspan="3">Course Title: Speech Recognition and Synthesis

Type of Course: Integrated</td><td>L- T-P- C</td><td>2</td><td>0</td><td>2</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="8">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="8">CSE2264</td></tr>
<tr><td>Anti-requisites</td><td colspan="8">NIL</td></tr>
<tr><td>Course Description</td><td colspan="8">This course introduces fundamental principles and practical aspects of speech signal processing. It covers techniques in speech analysis, recognition, and synthesis, enabling students to build interactive voice-based AI systems. Emphasis is placed on acoustic modeling, feature extraction, and the use of machine learning and deep learning models for speech applications.</td></tr>
<tr><td>Course Objective</td><td colspan="8">To understand the basic concepts and characteristics of speech signals.

To explore feature extraction and pattern matching techniques used in ASR.

To study the principles of speech synthesis and TTS systems.

To provide hands-on experience with speech processing tools and APIs.</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On successful completion of this course, students will be able to:

Analyze speech signals and extract key features.

Apply pattern recognition and machine learning methods for ASR.

Design speech synthesis systems using classical and deep learning models.

Develop real-time applications using speech APIs and open-source tools.</td></tr>
<tr><td colspan="9">Course Content:</td></tr>
<tr><td>Module 1</td><td>Speech Signal Fundamentals</td><td>Assignment</td><td colspan="4"></td><td colspan="2">18[8L+10P]

Sessions</td></tr>
<tr><td colspan="9">Topics:

Human speech production and auditory perception, Speech signal representation: time and frequency domains, Preprocessing: sampling, quantization, windowing, pre-emphasis, Speech signal features: pitch, formants, energy, ZCR, Spectrogram and Short-Time Fourier Transform (STFT).</td></tr>
<tr><td>Module 2</td><td>Feature Extraction & Modeling Techniques</td><td>Assignment</td><td colspan="4"></td><td colspan="2">14[7L+7P]

Sessions</td></tr>
<tr><td colspan="9">Topics:

MFCC, PLP, LPC, Delta features, DTW (Dynamic Time Warping), GMM-HMM based acoustic modelling, Viterbi decoding and alignment, Basics of phonetics and phoneme modelling</td></tr>
</table>

<table>
<tr><td>Module 3</td><td>Automatic Speech Recognition (ASR)</td><td>Assignment</td><td></td><td>14[6L+8P]
Sessions</td></tr>
<tr><td colspan="5">Topics:
Architecture of ASR systems, Language modeling: N-grams, smoothing, Deep learning for speech: DNN, CNN, LSTM, End-to-end models: CTC, Attention, Transformers, Tools: Kaldi, CMU Sphinx, DeepSpeech.</td></tr>
<tr><td>Module 4</td><td>Speech Synthesis and TTS</td><td>Assignment</td><td></td><td>14[6L+8P]
Sessions</td></tr>
<tr><td colspan="5">Topics:
Concatenative, Parametric, and Neural synthesis, TTS pipeline: text normalization, phoneme mapping, HMM-based synthesis, Tacotron and WaveNet architectures, APIs: Google TTS, Amazon Polly, Festival, eSpeak.</td></tr>
<tr><td colspan="5">List of Lab Tasks:

Lab 1: Introduction to Speech Signal Processing
Objective: Understand the nature of speech signals.
Task: Record and visualize a speech waveform using a microphone and Python.
Activity: Capture audio input, analyze waveform, and visualize with matplotlib.

Lab 2: Time Domain Analysis of Speech Signals
Objective: Analyze speech features in the time domain.
Task: Compute Zero Crossing Rate (ZCR) and short-time energy of speech samples.
Activity: Implement ZCR and energy plots for different speech segments using Python.

Lab 3: Frequency Domain Analysis Using Spectrogram
Objective: Understand frequency components of speech.
Task: Apply Short-Time Fourier Transform (STFT) to speech signals.
Activity: Generate and interpret spectrograms using Librosa and Matplotlib.

Lab 4: Extraction of MFCC Features
Objective: Extract key speech features using MFCC.
Task: Extract and visualize MFCC features from recorded speech.
Activity: Use Librosa or python_speech_features to extract MFCCs.

Lab 5: Linear Predictive Coding (LPC)
Objective: Implement LPC-based feature extraction.</td></tr>
</table>

Task: Apply LPC to model the vocal tract.

Activity: Compute LPC coefficients and analyze spectral envelope.

Lab 6: Implement Dynamic Time Warping (DTW)

Objective: Understand time alignment of speech.

Task: Compare two speech signals using DTW.

Activity: Use fastdtw to align utterances of the same word.

Lab 7: Acoustic Modeling using GMM-HMM

Objective: Implement basic acoustic modeling.

Task: Train a GMM-HMM model for a simple digit recognition task.

Activity: Use hmmlearn or HTK for acoustic modeling.

Lab 8: Viterbi Algorithm for Speech Alignment

Objective: Apply sequence decoding in speech.

Task: Use Viterbi decoding to find the best state path in an HMM.

Activity: Implement Viterbi algorithm in Python and visualize state paths.

Lab 9: Build a Simple ASR System using CMU Sphinx

Objective: Use open-source ASR toolkit.

Task: Set up CMU Sphinx and perform isolated word recognition.

Activity: Create language and acoustic models and test recognition.

Lab 10: Real-time Speech Recognition using DeepSpeech

Objective: Apply deep learning in ASR.

Task: Use Mozilla DeepSpeech to transcribe audio files.

Activity: Install DeepSpeech, load pre-trained model, and test transcription.

Lab 11: Evaluate ASR using Google Speech-to-Text API

Objective: Explore cloud-based speech recognition.

Task: Use Google Cloud API to transcribe different accents.

Activity: Send audio to API and analyze word error rate.

Lab 12: Introduction to Text-to-Speech (TTS) using Festival

Objective: Create basic speech synthesis output.

Task: Convert written text to speech using Festival.

Activity: Install Festival, input text, and generate synthesized speech.

Lab 13: Implement a Neural TTS system using Tacotron 2

Objective: Use deep learning for speech synthesis.

Task: Synthesize speech from text using Tacotron 2.

Activity: Use pre-trained Tacotron 2 model and generate speech samples.

Lab 14: Speech Synthesis using Google TTS and Amazon Polly

Objective: Use cloud-based TTS systems.

Task: Convert sample sentences into speech using APIs.

Activity: Use Python SDKs to access TTS services and compare outputs.

Lab 15: Mini Project – Build a Voice Assistant

Objective: Integrate ASR and TTS.

Task: Build a simple voice-controlled assistant.

Activity: Combine speech recognition, intent detection, and speech synthesis using tools like SpeechRecognition + gTTS + Pyttsx3.

REFERENCE MATERIALS

TEXTBOOKS

Lawrence Rabiner and Ronald Schafer, Theory and Applications of Digital Speech Processing, Pearson, 2011.

Daniel Jurafsky and James H. Martin, Speech and Language Processing, Pearson, 3rd Edition (Draft).
https://web.stanford.edu/~jurafsky/slp3/

REFERENCE BOOKS

Ben Gold and Nelson Morgan, Speech and Audio Signal Processing, Wiley, 2nd Edition, 2011.

Thomas Dutoit, An Introduction to Text-to-Speech Synthesis, Springer, 1997.

Xuedong Huang, Alex Acero, Hsiao-Wuen Hon, Spoken Language Processing, Prentice Hall, 2001.

Tokuda et al., Speech Synthesis: Algorithms for Text-to-Speech and Speech Modification, Springer, 2021.

JOURNALS / MAGAZINES

IEEE Transactions on Audio, Speech and Language Processing
https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=10376

Computer Speech & Language (Elsevier)
https://www.sciencedirect.com/journal/computer-speech-and-language

Speech Communication (Elsevier) https://www.journals.elsevier.com/speech-communication
SWAYAM / NPTEL / MOOCs NPTEL – Spoken Language Processing (IIT Madras) https://nptel.ac.in/courses/106106168 Coursera – Audio Signal Processing for Music Applications (UPF) https://www.coursera.org/learn/audio-signal-processing edX – Speech Processing (KTH Royal Institute of Technology) https://www.edx.org/course/speech-processing Fast.ai – Practical Deep Learning (TTS + ASR projects) https://course.fast.ai/

Course Code: CAI3410	Course Title: AI Chatbots without Programming Type of Course: Integrated	L- T-P- C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	CSE2264					
Anti-requisites	NIL					
Course Description	This course enables students to design and develop intelligent chatbots using no-code/low-code platforms. It covers the fundamentals of natural language processing, conversational AI, and chatbot design strategies. Students will gain hands-on experience building functional chatbots for domains such as customer service, education, and e-commerce using tools like Dialogflow, Chatfuel, Microsoft Power Virtual Agents, and other no-code frameworks.					
Course Objective	This course aims to democratize chatbot development by empowering students to create intelligent conversational agents without programming knowledge, using experiential learning on visual platforms.					
Course Outcomes	Course Outcomes On successful completion of this course, students will be able to: Understand the architecture and functioning of AI-powered chatbots. (Understand) Design conversational flows using drag-and-drop tools. (Apply) Analyze user intent and train NLP models using no-code tools. (Analyze) Create and deploy domain-specific chatbots for real-world use cases. (Create)					

Course Content:				
Module 1	Introduction to Conversational AI and Chatbots	Assignment		18[8L+10P] Sessions
Topics: History and evolution of chatbots,Types of chatbots: rule-based vs. AI-based,Components of chatbot architecture,Use cases across industries				
Module 2	Designing Conversational Experiences	Assignment		14[7L+7P] Sessions
Topics: Conversation design principles, User personas and intent mapping, Flowcharting and decision trees, Multilingual and accessibility considerations				
Module 3	Building AI Chatbots on No-Code Platforms	Assignment		14[6L+8P] Sessions
Topics: Overview of no-code tools: Dialogflow, Chatfuel, Landbot, Microsoft PVA,NLP basics: intents, entities, training phrases, Contexts and session handling, Integrations with messaging platforms (WhatsApp, Telegram, Web)				
Module 4	Testing, Deployment, and Analytics	Assignment		14[6L+8P] Sessions
Topics: Bot testing and improvement strategies, Connecting to APIs and databases, Deployment to websites and social media, Analyzing user behavior and feedback.				
Project work/Assignment:				
Design a customer support chatbot using Chatfuel or Dialogflow Develop a feedback collection chatbot for educational use Group project: Cross-platform chatbot for a chosen domain				
List of Lab Tasks: Lab 1: Introduction to chatbot interfaces and no-code tools Lab 2: Create a simple rule-based chatbot using Chatfuel				

Lab 3: Design a user flow using decision trees in Landbot

Lab 4: Build an FAQ chatbot using Dialogflow intents and responses

Lab 5: Implement intent recognition and entity extraction in Dialogflow

Lab 6: Add context-based conversations in a Dialogflow chatbot

Lab 7: Build a WhatsApp-integrated chatbot using Twilio

Lab 8: Design a chatbot using Microsoft Power Virtual Agents

Lab 9: Create multi-lingual responses and fallback messages

Lab 10: Integrate a chatbot with Google Sheets to log user responses

Lab 11: Embed a chatbot on a website using iframe or script

Lab 12: Analyze user interaction logs for performance metrics

Lab 13: Customize chatbot appearance and branding elements

Lab 14: Develop a feedback chatbot with sentiment-based responses

Lab 15: Final project: Design and deploy a fully functional domain-specific chatbot

REFERENCE MATERIALS

TEXTBOOKS

Jason D. Brown, Designing Bots: Creating Conversational Experiences, O'Reilly Media, 2017.

Akshay Kulkarni and Adarsha Shivananda, Building Chatbots with Google Dialogflow, Apress, 2019.

REFERENCES

Rashid Khan, Build Better Chatbots: A Complete Guide to Getting Started with Chatbots, Apress, 2017.

Michael McTear, Conversational AI: Dialogue Systems, Conversational Agents, and Chatbots, Springer, 2020.

Navin Sabharwal et al., Designing Human-Centric AI Experiences, Apress, 2021.

JOURNALS / MAGAZINES

ACM Transactions on Interactive Intelligent Systems

AI Magazine (Association for the Advancement of Artificial Intelligence)

Journal of Web Engineering

SWAYAM/NPTEL/MOOCs

Coursera – Building AI Powered Chatbots Without Programming (IBM)

edX – Introduction to Chatbots (Microsoft)

Udemy – Chatbot Development Without Coding

Course Code: CAI3411	Course Title: Generative AI Type of Course: Integrated		L-T-P-C	2	0	2	3
Version No.		1.0					

Course Pre-requisites		CSE2264			
Anti-requisites		NIL			
Course Description		This course builds the foundational insight of understanding generative AI models and to explore various architectures, algorithms and practices of Gen AI skills to accelerate strategic decision making with data and deliver cutting-edge products faster with GenAI-augmented software development and leverage Gen AI tools to optimize workflows.			
Course Objective		The objective of the course is to familiarize the learners to explore the competence in benchmarking and comprehend the potential generative AI models and techniques to revolutionize industries and create prominent Gen AI tools to attain Employability Skills through Experiential Learning techniques.			
Course Out Comes		On successful completion of the course the students shall be able to: CO 1: Infer the concepts of generative AI models and prompt engineering in tailoring customized outputs [Understand]. CO 2: Demonstrate attention mechanism and transformers architecture with practical Applications. [Apply]. CO 3: Practice advanced generative AI techniques using Langchain Python framework [Apply]. CO 4: Solve real-time applications using multi-modal generative AI models [Apply].			
Course Content:					
Module 1	Introduction to Generative AI	Participative Learning		Brainstorming session/Quiz	No. of classes L-6 P-8
	Topics: Introduction to Generative models: Historical perspective and evolution, Applications, Types of Generative models for different data modalities, Large Language Models (LLMs) – Introduction, evolution, Generative pre-trained transformers (GPT) and its variants, Google DeepMind’s, PaLM2, LLaMa and its series of models by Meta AI, Claud and its variants by Anthropic, Prompt Engineering-basic prompting.				
Module 2	Text-based Generative models	Participative Learning		Fish bowl, Think-pair & share	No. of classes L-8 P-6
	Topics: Text-based Generative models: State-of-the Art models, RNN, LSTM, Transformer Architecture, Transformer based Generative models: BERT, GPT, Training and Fine tuning LLMs for Generative task, Open AI’s Pre-trained transformers for Text Generation: ChatGPTs, Limitations of LLMs: Lack of context and Hallucination risks, Techniques to mitigate these limitations: chaining and retrieval augmentation, Workflow of an LLM application.				

Module 3	Introduction to Lang Chain	Experiential Learning		Implementation of Gen AI models using Langchain Framework	No. of classes L-8 P-8
	Topics: Introduction to Lang chain: Types, Components, Information retrieval using agents and tools in Lang chain, Retrieval Augmented Language Models (RaLM): Understanding Retrieval and vectors: Embeddings, Vector storage, Vector indexing, Vector Libraries, Vector Databases, Chatbot using memory and conversation buffer.				
Module 4	Generative models for other Data modalities	Project-based Learning		Multi-Modal Gen AI models for Realtime Applications	No. of classes L-8 P-8
	Topics: Generative Adversarial Networks (GAN): GAN Architecture, GAN variants, Neural Style transfer with GAN, Training GANs and common challenges, GAN applications in image and text generation, Variational Auto Encoders (VAEs) and its variants, Image generation models: Dall-E, MidJourney and stable diffusion: Architecture and components of stable diffusion, Text-to-image Generation, Parameter tuning, Image-to-image generation, Training custom models, In-Painting: Exchanging classes, Multi-modal generative models using Whisper for Audio: Speech-to-Text generation.				
	Project work/Assignment:				
	Certification course in Generative AI through Google Mini Project on (Module 3 and Module 4)				
	Targeted Application & Tools that can be used Open AI Generative AI models: GPT 3.5 Turbo, GPT 4.0 vision model, Dall-E 3.0, Lang Chain Framework in Python, Python IDE, Stable Diffusion, Gemini, Hugging Face,				
	List of Lab Tasks:				
	Experiment No.1: Setting up Python IDE(Spyder) and OpenAI API key. Introduction to OpenAI playground and prompting Level 1: Document the installation and the process for generating models in OpenAI Level 2: Solve various GenAI models of OpenAI from Playground using prompts				
	Experiment No.2: Text classification, summarization, sentiment analysis, chatbot application, code explanation with generating single and multiple response(S). Level 1: Practice the text generation model of OpenAI and Spyder IDE to implement various applications.				
	Experiment No.3: Embeddings – for words, similarity between words, text embeddings, plagiarism check of documents Level 1: Use generating embeddings for words, text and documents Level 2: Apply the embeddings API to develop applications for plagiarism check				
	Experiment No.4: Image generation using Dall E. Using GPT-Vision model for text to image generation and image-to-text. Level 1: Apply GPT-vision model for text-to-image generation and image-to-image				

	Experiment No.5: Transformer based text and email classification Level 1: Develop transformer-based AI models for classifying text/email
	Experiment No.6: BERT for masked token generation Level 1: Develop BERT based model for generating masked tokens
	Experiment No.7: Creating applications using different types of LangChains – Simple Sequential, Sequential and map reduce Level 1: List the various types of chains in Langchain Level 2: Practice different types of chains using Spyder IDE and OpenAI
	Experiment No.8: Information retrieval using agents and tools in Langchain. Level 1: Use agents and tools with Langchain for information retrieval
	Experiment No.9: Custom Document loading and retrieval in LangChain using ChromaDB Level 1: Understand ChromeDb Level 2: Apply chromed with Langchain to generate information retrieval model from custom document
	Experiment No.10: Create a GPT like Chatbot using the memory component and RALM in LangChain Level 1: Show GPT like chatbot using memory component and retrieval augmented language model
	Experiment No.11: Using action agents, human as a tool and plan and execute agents for information retrieval. Level 1: Understand action agents and plan and execute agents Level 2: Use agents and tools for information retrieval
	Experiment No.12: Implement GAN for neural style transfer Level 1: Demonstrate a style transfer algorithm using generative models and experiment with the transformation of images by applying different artistic styles, assessing both the technical aspects and the aesthetic outcomes
	Experiment No.13: Text to Image generation using Dall-e/stable diffusion using prompts Level 1: List various image generation models Level 2: Use an image generation model to generate image from prompts
	Experiment No.14: Image to Image generation using stable diffusion Level 1: Apply stable diffusion to generate image from an image using prompts
	Experiment No.15: Speech to text and multi-modal generative models using Whisper for Audio Level 1: Identify the generative model for text, image and audio data

	Level 2: Use Langchain to create models for generating different data modalities. Ex: Audio-to-text
	TEXT BOOKS: T1: Generative AI with LangChain, Ist Edition by Ben Auffarth, Packt. Inc. ISBN: 978-1-83508-346-8, Decemeber 2023. T2: Generative Deep Learning, 2nd Edition by David Foster, O'Reilly Media, Inc. ISBN: 9781098134181, May 2023. T3: Prompt Engineering for Generative AI, by James Phoenix, Mike Taylor, O'Reilly Media, Inc., ISBN:9781098153373, July 2024.
	REFERENCE BOOKS: R1. Bandi, A., Adapa, P. V. S. R., & Kuchi, Y. E. V. P. K. (2023). The power of Generative AI: a review of requirements, models, Input–Output formats, evaluation metrics, and challenges. Future Internet, 15(8), 260. https://doi.org/10.3390/fi15080260 R2. Barachini, F., & Stary, C. (2022). From digital twins to digital selves and beyond. In Springer eBooks. https://doi.org/10.1007/978-3-030-96412-2 R3. Hadi, M. U., Tashi, Q. A., Qureshi, R., Shah, A., Muneer, A., Irfan, M., Zafar, A., Shaikh, M. B., Akhtar, N., Wu, J., & Mirjalili, R4. S. (2023). Large Language Models: A Comprehensive Survey of its Applications, Challenges, Limitations, and Future Prospects. https://doi.org/10.36227/techrxiv.23589741.v4 R4. Hai-Jew, S. (n.d.). Generative AI in Teaching and Learning. IGI Global. R5. Salvaris, M., Dean, D., & Tok, W. H. (2018). Generative adversarial networks. In Apress eBooks (pp. 187–208). https://doi.org/10.1007/978-1-4842-3679-6_8
	MOOC’s/Swayam Courses/Online Courses: h https://onlinecourses.swayam2.ac.in/imb24_mg116/preview Certification Course by Google : 1. https://www.cloudskillsboost.google Introduction to Generative AI (Beginner) Gemini for Google Cloud (Intermediate) Generative AI for Developers (Advanced) 2. https://www.credly.com/badges/90e3eae0-87f3-44e3-af82-658e837aad3d/public_url 3. https://www.coursera.org/learn/generative-ai-with-llms 4. https://www.coursera.org/specializations/prompt-engineering

	ONLINE RESOURCES: W1. https://openai.com W2: https://python.langchain.com/v0.2/docs/introduction/ W3: https://www.udemy.com/course/master-ai-image-generation-using-stable-diffusion/?kw=Image+generation+using&src=sac&couponCode=LETSLEARNNOWPP W4: https://huggingface.co/google-t5/t5-base W5: https://dominguezdaniel.medium.com/exploring-image-generative-ai-models-9359705b15d3 W6: https://cloud.google.com/use-cases/retrieval-augmented-generation?hl=en# W7: https://ig.ft.com/generative-ai/ W8: https://medium.com/@samia.khalid/bert-explained-a-complete-guide-with-theory-and-tutorial-3ac9ebc8fa7c
	Topics relevant to "EMPLOYABILITY SKILLS": Topics of all four modules will help in developing Employability Skills through Experiential Learning techniques. This is attained through assessment component mentioned in course handout.

Course Code: CAI3412	Course Title: Machine Learning for Finance Type of Course: Integrated	L- T-P- C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	CSE2264					
Anti-requisites	NIL					
Course Description	This course explores the intersection of machine learning and finance. Students will learn to model financial data, predict market trends, manage risk, and develop algorithmic trading strategies using ML techniques. It emphasizes hands-on experience with financial datasets and real-world case studies.					
Course Objective	To enable students to apply machine learning methods to financial data analysis, portfolio optimization, and risk modeling. Students will gain practical knowledge to build ML-based financial systems using Python and related libraries.					

Course Outcomes	On successful completion of this course the students shall be able to: 1. Understand machine learning applications in the financial domain. (Understand) 2. Apply supervised and unsupervised learning to model financial data. (Apply) 3. Analyze risk and optimize portfolios using ML models. (Analyze) 4. Design and implement algorithmic trading strategies. (Create)		
Course Content:			
Module 1	Introduction to Financial Data and ML	Assignment 1	18[8L+10P] Sessions
Topics: Overview of financial markets, financial data types, returns and risk, ML in finance, financial time-series analysis, introduction to supervised learning models used in finance.			
Module 2	Financial Forecasting and Risk Modeling	Assignment 1	14[7L+7P] Sessions
Topics: Time series forecasting (ARIMA, LSTM), volatility modeling, Value at Risk (VaR), credit risk modeling, regression and classification models for default prediction.			
Module 3	Portfolio Optimization and Strategy Design	Assignment 2	14[6L+8P] Sessions
Topics: Portfolio theory, efficient frontier, ML for asset allocation, reinforcement learning in portfolio management, backtesting trading strategies.			
Module 4	Algorithmic Trading and Fraud Detection		14[6L+8P] Sessions
Topics: Overview of algorithmic trading, strategy development using ML, anomaly detection for fraud, real-time data analysis, regulatory and ethical considerations.			
Project work/Assignment:			
Assignment 1 on (Module 1 and Module 2) Assignment 2 on (Module 3)			
List of Lab Tasks:			

1. Load and analyze historical stock prices using pandas and yfinance.

2. Visualize financial time-series data and calculate returns.

3. Implement linear regression for stock price forecasting.

4. Build logistic regression model to predict credit default.

5. Use Random Forests to classify high-risk vs low-risk customers.

6. Implement ARIMA model for time-series forecasting.

7. Use LSTM model to predict stock prices with Keras/TensorFlow.

8. Apply K-Means clustering on customer transaction data.

9. Calculate and visualize Value at Risk (VaR) for a portfolio.

10. Optimize asset allocation using ML-based mean-variance optimization.

11. Backtest a trading strategy using historical stock data.

12. Implement reinforcement learning for portfolio management.

13. Detect financial fraud using anomaly detection techniques.

14. Build a real-time financial dashboard using Streamlit.

15. Mini-project: Develop and evaluate an ML model for a selected finance use case.

REFERENCE MATERIALS:

TEXTBOOKS

1. Yves Hilpisch, "Python for Finance: Mastering Data-Driven Finance", O'Reilly Media, 2nd Edition, 2018.
2. Marcos Lopez de Prado, "Advances in Financial Machine Learning", Wiley, 2018.

REFERENCES

1. Tucker Balch, "Machine Learning for Trading", Udacity course materials.
2. David Aronson, "Evidence-Based Technical Analysis", Wiley, 2006.
3. E. Tsang, "Foundations of Computational Finance with Machine Learning", Springer, 2021

JOURNALS/MAGAZINES

1. Journal of Financial Data Science

2. Quantitative Finance

3. Journal of Computational Finance

SWAYAM/NPTEL/MOOCs:

1. Machine Learning for Engineering and Science Applications

2. Artificial Intelligence: Search Methods for Problem Solving

3 Deep Learning

Course Code: CAI3413	Course Title: Industrial IoT Type of Course: Integrated	L- T-P- C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	CSE2264					
Anti-requisites	NIL					
Course Description	This course introduces the foundational concepts and applications of the Industrial Internet of Things (IIoT), emphasizing industrial automation, smart manufacturing, and predictive analytics. Students will gain hands-on experience with sensor integration, cloud platforms, and industrial communication protocols necessary for developing and managing IIoT systems.					
Course Objective	To provide practical skills and theoretical knowledge for designing, implementing, and managing Industrial IoT applications in real-world industrial and manufacturing environments.					
Course Outcomes	On successful completion of the course, students will be able to: Understand the architecture and ecosystem of Industrial IoT systems. Integrate sensors and edge devices for real-time industrial data monitoring. Utilize cloud computing and analytics for IIoT-based applications. Apply communication protocols and security mechanisms relevant to industrial environments.					

Course Content:				
Module 1	Introduction to Industrial IoT	Assignment		18[8L+10P] Sessions
Topics: Fundamentals of IoT and IIoT: Definitions, history, evolution, IIoT vs. Consumer IoT, IIoT Architecture Layers: Perception, Network, Middleware, Application Industrial applications: Smart factories, Energy grids, Process automation Introduction to Industry 4.0 and its pillars (Cyber-Physical Systems, Big Data, Cloud Computing), Business benefits and ROI of IIoT deployment Challenges in IIoT: Scalability, legacy systems, interoperability, security, Standards and regulatory compliance in IIoT (ISA-95, ISO/IEC 30141).				
Module 2	Devices and Communication Protocols	Assignment		14[7L+7P] Sessions
Topics: Types of Sensors and Actuators: Environmental, Proximity, Motion, Flow, Vibration, Microcontrollers and Development Boards: Arduino, Raspberry Pi, ESP32, IIoT Gateways and Edge Devices: Intel				

NUC, Jetson Nano, Communication Technologies: Wired: Modbus RTU, CAN, Ethernet/IP,Wireless: Zigbee, LoRaWAN, Wi-Fi, NB-IoT, Bluetooth LE, Protocols for IIoT:MQTT: Publish-Subscribe Model,OPC-UA: Industrial interoperability and data exchange, CoAP, HTTP/HTTPS,Integration with SCADA and PLC Systems,Device provisioning and configuration management, Network Topologies and Addressing in IIoT environments.				
Module 3	IIoT Data Processing and Analytics	Assignment		14[6L+8P] Sessions
Topics: Data Acquisition: Sampling rate, ADC/DAC, Signal conditioning, Local Storage: SQLite, Edge databases, Stream Processing: Apache Kafka, Apache Flink, Data Preprocessing: Noise reduction, outlier detection, filtering techniques, Introduction to Edge Computing and Fog Computing, Real-time vs. Batch Analytics:Predictive Analytics in Manufacturing:Predictive maintenance models,Failure prediction using historical data,Machine Learning for Sensor Data: Regression, Clustering, Classification,Anomaly Detection in Industrial Systems,Data Encryption and Access Control at Edge and Cloud,Security Threats: DDoS, firmware tampering, man-in-the-middle attacks, Best practices for data governance and GDPR compliance				
Module 4	IIoT Cloud Integration and Applications			
Overview of Cloud Computing Models (IaaS, PaaS, SaaS) in IIot, IIoT Cloud Platforms: AWS IoT Core: Device Shadow, Rule Engine, Azure IoT Hub and IoT Central, Google Cloud IoT Core, Device-to-Cloud Communication Models, Storage Solutions: Amazon S3, Azure Blob Storage, InfluxDB, Visualization Tools: Grafana, Power BI, Google Data Studio, Case Studies:Digital Twin of a robotic arm, Smart HVAC system for energy optimization,Real-time supply chain visibility, Building Custom Dashboards and Alerts,Integration with ERP and MES Systems,Final Capstone Project:Design, simulate, and evaluate an end-to-end IIoT system, Include edge device, communication, cloud, analytics, and visualization.				
Project work/Assignment:				
Assignment 1: Sensor Data Acquisition and Visualization Assignment 2: Edge-Based Analytics for Predictive Maintenance Mini Project (Team-based): End-to-End IIoT System for a Smart Industry Scenario				
Setup Raspberry Pi/Arduino for IIoT applications. Interface DHT11, vibration, and ultrasonic sensors. Send sensor data via MQTT to a cloud broker. Create Node-RED dashboards for IIoT data. Build OPC-UA server and client communication. Log and visualize sensor data using Python. Apply edge analytics using Raspberry Pi and filtering techniques. Stream real-time data using Kafka. Integrate with AWS IoT Core for data monitoring. Forecast sensor values using LSTM (predictive maintenance). Detect anomalies in sensor data using Scikit-learn. Connect multiple IIoT devices into a secure network.				

Simulate a digital twin for a production line.

Develop a simple IIoT-based security alert system.

Capstone Project: Deploy an end-to-end IIoT prototype for a smart manufacturing scenario.

REFERENCE MATERIALS:

TEXTBOOKS

Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016.

Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, Industrial Internet of Things, Springer, 2017.

REFERENCES

Arshdeep Bahga, Vijay Madisetti, Internet of Things: A Hands-On Approach, Universities Press, 2015.

Hakima Chaouchi, The Internet of Things: Connecting Objects, Wiley, 2010.

Rajkumar Buyya, Amir Vahid Dastjerdi, Internet of Things: Principles and Paradigms, Morgan Kaufmann, 2016.

JOURNALS/MAGAZINES

IEEE Internet of Things Journal
https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=6488907
Publishes articles on the design, development, and deployment of IoT applications in industrial settings.

ACM Transactions on Internet of Things (TIOT)
https://dl.acm.org/journal/tiot
Covers architectures, algorithms, and applications related to IoT including edge computing and real-time analytics.

Sensors (MDPI - Special Issue on Industrial IoT)
https://www.mdpi.com/journal/sensors
Features studies on sensor development, wireless communication, and industrial sensor networks.

Journal of Industrial Information Integration (Elsevier)
https://www.sciencedirect.com/journal/journal-of-industrial-information-integration
Focuses on integrating data from industrial systems for smart manufacturing and digital twins.

IEEE Spectrum – IoT and Industry 4.0
https://spectrum.ieee.org/
Publishes accessible articles on cutting-edge tech including IIoT, smart robotics, and industrial AI.

Industrial IoT World – Insights & Reports
https://www.iiot-world.com/
Offers case studies, whitepapers, and expert commentary on real-world IIoT deployments.

Automation World
https://www.automationworld.com/
Covers automation systems, IIoT trends, cloud integration, and edge devices.

Industry 4.0 Magazine (Industry40.today)
https://industry40.today/
Industry-focused magazine offering updates on cyber-physical systems, smart factories, and digital transformation.

Regularly features expert opinion, trends, and technologies including AI in cyber security.

SWAYAM/NPTEL/MOOCs: NPTEL – Industrial Internet of Things (IIT Kharagpur) Instructor: Prof. Sudip Misra https://onlinecourses.nptel.ac.in/noc23_cs69/preview NPTEL – Introduction to Industry 4.0 and Industrial Internet of Things (IIT Roorkee) Instructor: Prof. Sudeb Dasgupta https://onlinecourses.nptel.ac.in/noc21_me88/preview ☐

Course Code: CAI3414	Course Title: Smart Farming Type of Course: Integrated	L- T-P- C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	CSE2264					
Anti-requisites	NIL					
Course Description	This course introduces the interdisciplinary domain of Smart Farming, integrating IoT, AI, cloud computing, and sensor networks to enable precision agriculture. Students will learn how to design, develop, and deploy data-driven agricultural systems for real-time monitoring, crop management, and decision-making.					
Course Objective	To provide practical and theoretical insights into the application of smart technologies in agriculture, with emphasis on sustainable practices, yield optimization, and automation.					
Course Outcomes	On successful completion of this course, students will be able to: Understand the fundamentals of smart agriculture and its ecosystem. Apply IoT and sensors for environmental and crop monitoring. Analyze agricultural data for predictive insights using AI/ML. Design and deploy smart farming solutions using cloud and mobile platforms.					
Course Content:						

Module 1	Introduction to Smart Farming	Assignment		18[8L+10P]

<table>
<tr><td></td><td>and Precision Agriculture</td><td></td><td></td><td>Sessions</td></tr>
<tr><td colspan="5">Topics:

Evolution from traditional to precision agriculture, Components and architecture of Smart Farming systems, Applications: crop monitoring, irrigation control, pest detection, Overview of remote sensing and satellite-based agriculture, Soil health and weather data integration.</td></tr>
<tr><td>Module 2</td><td>IoT and Sensor Systems in Agriculture</td><td>Assignment</td><td></td><td>14[7L+7P]

Sessions</td></tr>
<tr><td colspan="5">Topics:

Sensor types: soil moisture, temperature, humidity, pH, NDVI, Microcontrollers: Arduino, ESP32, Raspberry Pi,Wireless communication protocols: LoRa, Zigbee, Wi-Fi, GSM, Energy harvesting and power management for field devices, Edge computing in agriculture.</td></tr>
<tr><td>Module 3</td><td>Data Analytics and AI in Agriculture</td><td>Assignment</td><td></td><td>14[6L+8P]

Sessions</td></tr>
<tr><td colspan="5">Topics:

Introduction to agri-data lifecycle, Data preprocessing and anomaly detection, AI/ML techniques: regression, classification, clustering for yield prediction and disease detection,Time series forecasting for rainfall, irrigation, and climate impact, Decision support systems and dashboards.</td></tr>
<tr><td>Module 4</td><td>Cloud, Mobile, and Drone Integration</td><td></td><td></td><td></td></tr>
<tr><td colspan="5">Cloud platforms for agriculture: ThingSpeak, AWS IoT, Blynk, Azure IoT, Mobile app integration for farmer advisory systems, Role of drones in smart agriculture: aerial imaging, spraying, crop health assessment, Case studies: smart greenhouses, hydroponics, aquaponics, Capstone: End-to-end smart farming system design.</td></tr>
<tr><td colspan="5">Project work/Assignment:</td></tr>
<tr><td colspan="5">Assignment 1: Real-Time Crop and Soil Monitoring System

Assignment 2: Crop Yield Prediction using Machine Learning

Mini Project (Team-based): Smart Farm Automation System</td></tr>
<tr><td colspan="5">List of Lab Tasks :

☐ Setup Arduino/ESP32 for collecting soil and climate data

☐ Interface with soil moisture, DHT11, and pH sensors

☐ Transmit data wirelessly using LoRa or Wi-Fi

☐ Real-time dashboard for field data (using Blynk/ThingSpeak)

☐ Predict crop yield using linear regression

☐ Train an image classifier for leaf disease detection

☐ Setup automated irrigation control system

☐ Use GPS for geotagging sensor data

☐ Drone-based simulation for crop monitoring

☐ Preprocess and visualize multivariate agri-data using Python</td></tr>
</table>

☐ Connect field devices to cloud platform (AWS IoT or Firebase)

☐ Alert system for low soil moisture via SMS/email

☐ Forecast rainfall using time series techniques

☐ Build a mobile-based decision support system (low-code platform)

☐ Capstone: Build and present a complete Smart Farm prototype

REFERENCE MATERIALS:

TEXTBOOKS

☐ Rajesh Singh, Anita Gehlot, Bhupendra Singh, Internet of Things and Wireless Sensor Networks in Smart Agriculture, CRC Press, 2021.

☐ Subhas Chandra Mukhopadhyay, Internet of Things in Smart Agriculture, Springer, 2020.

REFERENCES

Himanshu Patel, Smart Farming Technologies for Sustainable Agricultural Development, IGI Global, 2020.

G. R. Kanagachidambaresan, Internet of Things for Sustainable Community Development, Springer, 2021.

IEEE Papers and Reports on Smart Agriculture, Remote Sensing, and Precision Farming

JOURNALS/MAGAZINES

☐ EEE Access – Special Section on Smart Agriculture

☐ Computers and Electronics in Agriculture (Elsevier)

☐ Agricultural Systems Journal

☐ Smart Farming Magazine

☐ IoT for Agri-Tech (IoT World Today)

SWAYAM/NPTEL/MOOCs:

☐ NPTEL – Introduction to Smart Agriculture (IIT Kanpur)
🔗 https://onlinecourses.nptel.ac.in/noc22_ge15/preview

☐ NPTEL – Applications of IoT in Agriculture (IIT Kharagpur)
🔗 https://onlinecourses.nptel.ac.in/noc23_cs91/preview

☐ Coursera – Smart Agriculture with IoT
🔗 https://www.coursera.org/learn/smart-agriculture-iot

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Course Code: CAI3415	Course Title: AI for Autonomous Systems	L- T-P- C				

	Type of Course: Integrated		2	0	2	3

Version No.	1.0
Course Pre-requisites	CSE2264
Anti-requisites	NIL
Course Description	This course introduces the principles and technologies involved in developing intelligent autonomous systems using Artificial Intelligence. It focuses on perception, decision-making, control systems, and learning-based approaches to build real-time, autonomous agents such as self-driving vehicles, drones, and mobile robots.
Course Objective	To equip students with knowledge and practical skills in using AI techniques to develop safe, adaptive, and intelligent autonomous systems that can sense, plan, and act in dynamic environments.
Course Outcomes	On completion of this course, students will be able to: Understand the architectural components of autonomous systems. Apply computer vision and sensor fusion for environmental perception. Develop path planning and control strategies for autonomous navigation. Implement learning-based models for real-time decision making.

Course Content:

Module 1	Introduction to Autonomous Systems	Assignment		18[8L+10P] Sessions

Definition and types of autonomous systems, Key components: perception, planning, control, learning, Applications: Self-driving cars, drones, mobile robots, AGVs, Architecture of an autonomous system: sensors, actuators, processors, ROS (Robot Operating System) overview, Ethical and safety concerns in autonomy.

Module 2	Perception and Sensor Fusion	Assignment		14[7L+7P] Sessions

Topics:

Sensor types: LiDAR, Radar, Ultrasonic, IMU, GPS, Cameras, Environment mapping: Occupancy grid, SLAM, Visual perception: Object detection (YOLO, SSD), semantic segmentation, Sensor fusion techniques: Kalman filter, EKF, particle filter,Case study: Lane detection using OpenCV

Module 3	Planning and Navigation	Assignment		14[6L+8P] Sessions

Topics:

Path planning algorithms: Dijkstra, A*, RRT, D*, Obstacle avoidance: Dynamic Window Approach, Potential Fields, Localization: Monte Carlo Localization, Graph-based SLAM,Trajectory generation and smoothing,Behavior trees and state machines for task execution,Indoor vs. outdoor navigation.

Module 4	Learning-based Control and Decision Making			

Reinforcement learning: Q-learning, Deep Q-Networks, Policy-based learning and imitation learning, Decision making under uncertainty (Markov Decision Processes)Learning from simulation (Gazebo, CARLA, Webots), Edge AI deployment for low-latency inference, Case studies: Autonomous driving stack, warehouse robot planner.

Project work/Assignment:

Assignment 1: Object Detection and Lane Tracking System

Assignment 2: Path Planning Simulator

Mini Project (Team-based): Autonomous System Prototype

List of Lab Tasks (15 Labs):

Simulate a differential drive robot in ROS

Interface camera and distance sensors with Raspberry Pi

Perform object detection using pre-trained YOLOv5

Apply color-based segmentation for road/lane detection

Fuse GPS and IMU data using a Kalman filter

Build a simple SLAM model using GMapping or Cartographer

Implement obstacle avoidance using LiDAR data

Visualize path planning using A* on a grid map

Simulate autonomous vehicle in CARLA/Gazebo

Implement PID control for motor speed regulation

Train a reinforcement learning agent to navigate a maze

Deploy a TensorFlow Lite model for edge object recognition

Evaluate decision trees for robotic task selection

Use OpenCV to detect traffic signs and lights

Capstone: Build and test a mini autonomous robot prototype

REFERENCE MATERIALS:

TEXTBOOKS

Raj Madhavan, Autonomous Systems: Issues and Challenges, Springer, 2021

Peter Corke, Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer, 2017

REFERENCES

Sebastian Thrun et al., Probabilistic Robotics, MIT Press, 2005

Benjamin Kuipers, Principles of Intelligent Autonomous Systems, MIT Press, 2016

Deepak Khemani, A First Course in Artificial Intelligence, McGraw-Hill, 2013

JOURNALS/MAGAZINES

IEEE Transactions on Robotics

Journal of Field Robotics (Wiley)

Autonomous Robots (Springer)

IEEE Transactions on Intelligent Vehicles

SWAYAM/NPTEL/MOOCs:

NPTEL – Robotics: Perception, Planning and Control (IIT Kanpur)
https://onlinecourses.nptel.ac.in/noc21_ee68/preview

NPTEL – Artificial Intelligence: Search Methods for Problem Solving (IIT Madras)
https://onlinecourses.nptel.ac.in/noc21_cs53/preview

Self-Driving Cars Specialization (University of Toronto)
https://www.coursera.org/specializations/self-driving-cars

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Course Code: CAI3416	Course Title: Edge Computing Type of Course: Integrated		L- T-P- C	2	0	2	3
Version No.	1.0						
Course Pre-requisites	CSE2264						
Anti-requisites	NIL						
Course Description	This course introduces the fundamentals of edge computing, an emerging paradigm that enables data processing and analytics at the network's edge. It covers system architecture, communication protocols, edge AI, and real-time applications with a hands-on approach using edge devices.						
Course Objective	To equip students with knowledge and skills in designing and deploying edge computing systems that offer low-latency, energy-efficient, and scalable solutions for real-time and distributed applications.						
Course Outcomes	After successful completion, students will be able to: Explain the principles and architecture of edge computing systems. Develop and deploy applications on edge devices like Raspberry Pi, Jetson Nano, etc. Integrate edge computing with IoT, cloud, and AI systems. Analyze and optimize performance of edge-based applications.						
Course Content:							
Module 1	Introduction to Edge Computing	Assignment				18[8L+10P] Sessions	
Topics: Evolution from cloud to fog to edge, Edge computing architecture: core, edge, and device layers, Use cases: smart cities, industrial automation, healthcare, autonomous systems, Edge vs. Cloud:							

latency, bandwidth, privacy, scalability, Edge device overview: Raspberry Pi, Nvidia Jetson, Coral Dev Board				
Module 2	Edge Devices and Communication	Assignment		14[7L+7P] Sessions
Topics: Edge device setup and configuration, Operating systems: Raspbian, Ubuntu Core, Yocto, Edge and fog networking protocols: MQTT, CoAP, 6LoWPAN, Containerization with Docker at the edge, Device orchestration and provisioning, Energy and resource management in constrained devices.				
Module 3	Edge AI and Analytics	Assignment		14[6L+8P] Sessions
Topics: Edge AI: Concepts and advantages, Lightweight ML frameworks: TensorFlow Lite, ONNX, OpenVINO, Model quantization and compression for deployment, Real-time data processing and event-based analytics, Case studies: object detection, audio classification, sensor fusion, Ethical considerations and security at the edge				
Module 4	Edge-Cloud Integration and Applications			
Edge-to-cloud communication pipelines, AWS Greengrass, Azure IoT Edge, Google Edge TPU, Microservices and serverless architecture on the edge, Industrial edge computing with OPC-UA and Modbus, Building dashboards for edge data insights, Capstone: End-to-end edge system for real-world application.				
Project work/Assignment:				
Assignment 1: IoT Data Stream Processing at the Edge Assignment 2: Edge AI Inference Deployment Mini Project (Team-based): Real-World Edge Solution				
List of Lab Tasks : Setting up Raspberry Pi or Jetson Nano for edge deployment Installing and configuring Docker on an edge device Connecting sensors (camera, DHT11, ultrasonic) to edge devices Building and running MQTT-based data pipeline Collecting and visualizing data using Node-RED or Grafana Edge inference using TensorFlow Lite object detection model Deploying ONNX model for sensor-based classification Streaming video analytics at the edge Building a containerized AI service on the edge Edge-to-cloud integration using AWS Greengrass or Azure IoT Edge Monitoring resource usage on constrained devices Detecting anomalies in time-series data at the edge				

Designing a simple mobile dashboard to view edge insights

Security setup: HTTPS, authentication, and encryption

Capstone: Build a complete edge-to-cloud application prototype.

REFERENCE MATERIALS:

TEXTBOOKS

Perry Lea, Edge Computing: From Hype to Reality, Packt Publishing, 2020

Mahmoud Tawfik, Edge Computing and Internet of Things for Smart Agriculture, Springer, 2021

REFERENCES

Satyanarayanan M., The Emergence of Edge Computing, IEEE Computer, 2017

Flavio Bonomi et al., Fog Computing and Its Role in the Internet of Things, MCC Workshop, ACM 2012

OpenFog Consortium Architecture White Paper, 2017

JOURNALS/MAGAZINES

IEEE Internet of Things Journal

ACM Transactions on Internet Technology (TOIT)

IEEE Edge Computing Magazine

Elsevier Future Generation Computer Systems – Special Issues on Edge Computing

SWAYAM/NPTEL/MOOCs:

NPTEL – Cloud Computing and Distributed Systems (IIT Kharagpur)
https://onlinecourses.nptel.ac.in/noc22_cs62/preview

NPTEL – Internet of Things (IIT Kharagpur)
https://onlinecourses.nptel.ac.in/noc21_cs60/preview

Coursera – Edge AI and Computer Vision (Intel + OpenVINO)
https://www.coursera.org/learn/introduction-to-edge-ai

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Course Code: CAI3417	Course Title: Cognitive Computing Type of Course: Integrated	L- T-P- C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	CSE2264					

Anti-requisites	NIL			
Course Description	This course explores the interdisciplinary domain of Cognitive Computing, inspired by the human brain's capability to reason, learn, and interact naturally. Students will study the fundamentals of cognitive systems, natural language processing, machine learning, and AI-driven decision-making, with a focus on building intelligent applications using IBM Watson, transformers, and cognitive APIs.			
Course Objective	To understand the principles of cognitive systems and their architecture To explore the components of natural language understanding and reasoning To apply AI and ML models in cognitive tasks such as Q&A, dialogue, and speech To implement and evaluate real-world cognitive applications			
Course Outcomes	Upon successful completion, students will be able to: Explain the structure and functioning of cognitive computing systems Apply NLP and ML techniques to build cognitive applications Use cognitive computing APIs for speech, vision, and language understanding Develop intelligent solutions using IBM Watson and other platforms			
Course Content:				
Module 1	Introduction to Cognitive Computing	Assignment		18[8L+10P] Sessions
Topics: Definition and evolution of cognitive computing, Cognitive architecture: perception, reasoning, learning, decision-making, Differences between traditional AI and cognitive systems, Applications in healthcare, finance, education, and law.				
Module 2	Machine Learning in Cognitive Systems	Assignment		14[7L+7P] Sessions
Topics: Supervised, unsupervised, and reinforcement learning basics, Neural networks and deep learning, Introduction to cognitive frameworks (IBM Watson, Microsoft Azure AI, Google AI), Cognitive APIs for image, speech, and text processing				
Module 3	Natural Language Processing and Understanding	Assignment		14[6L+8P] Sessions
Topics: Language modeling, tokenization, stemming, lemmatization, Sentiment analysis, named entity recognition (NER), and summarization, Conversational AI: chatbots and voice assistants, Transformer models: BERT, GPT, and question answering systems.				
Module 4	Building Cognitive Applications	Assignment		14[6L+8P] Sessions

Topics: Knowledge representation and reasoning, Integrating cognitive APIs (speech-to-text, text-to-speech, visual recognition), Ethical considerations and trust in cognitive systems, Cognitive services deployment and case studies.
List of Lab Tasks Lab 1: Introduction to Cognitive Computing Platforms Objective: Explore IBM Watson and Azure Cognitive Services Task: Register and configure accounts for cloud-based cognitive tools Activity: Build a simple "Hello Cognitive World" app
Lab 2: Sentiment Analysis using IBM Watson NLP API Objective: Analyze emotional tone of user-generated content Task: Use Watson's NLP API to detect sentiment Activity: Visualize sentiment trends in tweets or reviews
Lab 3: Named Entity Recognition using spaCy Objective: Extract key entities from text Task: Identify names, places, and organizations Activity: Highlight named entities using Python and spaCy
Lab 4: Speech-to-Text using Google Cloud API Objective: Convert speech input into text Task: Use Google Cloud Speech API Activity: Transcribe audio files with speaker diarization
Lab 5: Text-to-Speech using IBM Watson TTS Objective: Generate human-like speech from text Task: Convert user input to spoken voice Activity: Play synthesized speech in a web app
Lab 6: Build a Visual Recognition App Objective: Identify objects in images Task: Use IBM Watson Visual Recognition API Activity: Upload image and detect labels or tags
Lab 7: Design a Conversational Chatbot with Dialogflow Objective: Implement intent-based conversation flow Task: Create intents, entities, and responses Activity: Deploy chatbot on a web interface
Lab 8: Question Answering with Transformers Objective: Use BERT to answer questions based on context Task: Load pre-trained model and context documents Activity: Ask and receive accurate answers using Hugging Face
Lab 9: Create a Knowledge Graph using Neo4j Objective: Represent relationships among entities

Task: Build and query knowledge graphs Activity: Visualize connections in graph format
Lab 10: Sentiment Classification with LSTM Objective: Classify text as positive/negative Task: Train LSTM model for binary sentiment Activity: Evaluate with accuracy and confusion matrix
Lab 11: Image Captioning with CNN-RNN Architecture Objective: Generate captions for images Task: Integrate image features and text generation Activity: Display image and generate natural description
Lab 12: Facial Expression Recognition using OpenCV Objective: Detect and classify facial emotions Task: Use emotion classification models Activity: Real-time expression detection from webcam
Lab 13: Design a Voice Assistant using Python Objective: Enable basic voice interaction Task: Use speech recognition and TTS Activity: Query weather, date, and time via voice
Lab 14: Ethical Use of Cognitive Computing Tools Objective: Understand ethical AI deployment Task: Analyze bias and fairness in models Activity: Present case studies on responsible AI
Lab 15: Capstone Project – Build a Multi-Modal Cognitive App Objective: Integrate speech, vision, and language Task: Develop a chatbot with voice and visual recognition Activity: Demonstrate and document full application pipeline
REFERENCE MATERIALS TEXTBOOKS Judith Hurwitz, Marcia Kaufman, Cognitive Computing and Big Data Analytics, Wiley, 2015 Rajiv Mathur, Cognitive Computing: Theory and Applications, CRC Press, 2022
REFERENCE BOOKS Rob High, The Era of Cognitive Systems: An Inside Look at IBM Watson and How it Works, IBM Redbooks Adnan Masood, Cognitive Computing Recipes: AI and Machine Learning Applications Using IBM Watson, Apress, 2019 Sebastian Raschka, Natural Language Processing with Transformers, O'Reilly, 2021

JOURNALS / MAGAZINES IEEE Intelligent Systems ACM Transactions on Interactive Intelligent Systems (TIIS) Cognitive Computation (Springer) Journal of Artificial Intelligence Research (JAIR)
SWAYAM / NPTEL / MOOCs NPTEL – Deep Learning for Computer Vision (IIT Hyderabad) https://nptel.ac.in/courses/106106231 Coursera – Introduction to IBM Watson (IBM) https://www.coursera.org/learn/ai-watson edX – IBM Applied AI: Cognitive Services https://www.edx.org/professional-certificate/ibm-applied-artificial-intelligence

Course Code: CAI3418	Course Title: Geospatial Data Analytics Type of Course: Integrated	L- T-P- C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	CSE2264					
Anti-requisites	NIL					
Course Description	This course introduces the fundamentals of geospatial data and spatial analysis using modern analytical tools and technologies. It focuses on acquiring, visualizing, processing, and analyzing geographic data to extract meaningful patterns. Applications include urban planning, environmental monitoring, remote sensing, and location-based services.					
Course Objective	To understand the fundamentals of geospatial data and coordinate systems To perform spatial data processing and analysis using GIS tools To visualize geospatial data using mapping libraries and dashboards To apply machine learning and statistical models to spatial datasets					
Course Outcomes	Upon successful completion of this course, students will be able to: Work with different types of geospatial data and formats Perform spatial analysis and geoprocessing Build visualizations using GIS platforms and Python libraries Apply geospatial techniques for problem-solving in real-world scenarios					
Course Content:						

Module 1	Introduction to Geospatial Data and GIS	Assignment		18[8L+10P] Sessions
Topics: Basics of geospatial data: raster vs vector, Coordinate reference systems (CRS) and map projections, GIS architecture and components, Geospatial data sources: satellite, drone, GPS, open data.				
Module 2	Geospatial Data Handling and Visualization	Assignment		14[7L+7P] Sessions
Topics: Shapefiles, GeoJSON, and TIFF formats, Loading and manipulating geospatial data with GeoPandas, Map visualizations with Folium, Kepler.gl, and Plotly, Spatial joins, clipping, filtering, and reprojection				
Module 3	Spatial Analysis and Remote Sensing	Assignment		14[6L+8P] Sessions
Topics: Overlay operations, buffering, and geoprocessing, Raster analysis using rasterio, Remote sensing concepts and multispectral image analysis, NDVI, LST, and change detection from satellite images.				
Module 4	Applications and Machine Learning in Geospatial Analytics	Assignment		14[6L+8P] Sessions
Topics: Spatial clustering and hotspot analysis, Geospatial ML: land cover classification, object detection, Time series and spatiotemporal data analysis, Case studies in disaster management, urban planning, and climate monitoring.				
List of Lab Tasks Lab 1: Introduction to QGIS and Map Projections Objective: Understand GIS interface and coordinate systems Tasks: Load vector data and explore CRS Activity: Visualize administrative boundaries and reproject layers Lab 2: Handle Vector Data using GeoPandas Objective: Load and manipulate shapefiles in Python Tasks: Read, filter, and plot shapefile data Activity: Analyze India’s state-level boundaries using GeoPandas Lab 3: Perform Spatial Joins and Buffering Objective: Learn spatial joins and geoprocessing Tasks: Combine population and boundary datasets Activity: Create buffer zones around city centers				

Lab 4: Visualize Maps using Folium and Kepler.gl Objective: Create interactive maps Tasks: Generate heatmaps and choropleth maps Activity: Visualize crime or COVID-19 data on an interactive map
Lab 5: Work with Raster Data using Rasterio Objective: Read and manipulate satellite imagery Tasks: Load and clip raster images Activity: Display elevation or vegetation maps
Lab 6: Calculate NDVI from Satellite Images Objective: Perform vegetation index analysis Tasks: Use Red and NIR bands to compute NDVI Activity: Visualize vegetation cover changes
Lab 7: Geocoding and Reverse Geocoding Objective: Convert addresses to coordinates Tasks: Use Geopy and Google Maps API Activity: Geocode location list and map them
Lab 8: Perform Land Use Classification using K-Means Objective: Apply clustering to satellite images Tasks: Use unsupervised learning on raster data Activity: Classify urban vs green areas
Lab 9: Detect Change over Time in Remote Sensing Data Objective: Analyze temporal changes Tasks: Compare satellite images from different years Activity: Detect urban expansion or deforestation
Lab 10: Build Dashboard using Plotly and Dash Objective: Create an interactive geospatial dashboard Tasks: Combine charts and maps Activity: Display flood zones with demographic data
Lab 11: Perform Hotspot and Cluster Analysis Objective: Identify spatial patterns Tasks: Use DBSCAN or Getis-Ord Gi* statistic Activity: Detect crime or disease hotspots
Lab 12: Integrate GPS Data for Route Mapping Objective: Process and visualize GPS tracks Tasks: Load GPX/CSV files and plot paths Activity: Analyze cycling or delivery routes

Lab 13: Apply Spatial Regression Models Objective: Model spatial relationships Tasks: Fit spatial autoregression (SAR) or GWR Activity: Predict housing prices based on location
Lab 14: Use Google Earth Engine for Remote Sensing Analysis Objective: Access cloud-based satellite processing Tasks: Load and analyze Sentinel/Landsat data Activity: Monitor water bodies or land surface temperature
Lab 15: Capstone – Geospatial Data Analytics Project Objective: Apply geospatial techniques to a real dataset Tasks: Perform end-to-end analysis Activity: Present findings via dashboard or report

REFERENCE MATERIALS

TEXTBOOKS

Paul Longley et al., Geographic Information Systems and Science, Wiley, 4th Edition, 2015

Bolstad, Paul, GIS Fundamentals: A First Text on Geographic Information Systems, Eider Press, 6th Edition, 2019

REFERENCE BOOKS

Michael Dorman, Spatial Data Analysis in Python, Manning Publications, 2023

Andrew Cutts, Geospatial Analysis: A Comprehensive Guide, Winchelsea Press

Bonny P. McClain, Mastering Geospatial Analysis with Python, Packt Publishing, 2022

JOURNALS / MAGAZINES

International Journal of Geographical Information Science

Remote Sensing of Environment

Journal of Spatial Information Science

GIScience & Remote Sensing

SWAYAM / NPTEL / MOOCs

NPTEL – Introduction to GIS (IIT Roorkee)
https://nptel.ac.in/courses/105107120

Coursera – Geospatial and Environmental Analysis (UC Davis)
https://www.coursera.org/learn/environmental-analysis

edX – Geospatial Data Science and Applications (Tsinghua University)
https://www.edx.org/course/geospatial-data-science

Google Earth Engine Tutorials
https://developers.google.com/earth-engine/tutorials

Course Code: CAI3419	Course Title: AI for energy consumption optimization Type of Course: Integrated	L- T-P- C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	CSE2264					
Anti-requisites	NIL					
Course Description	This course provides an in-depth study of how artificial intelligence can be leveraged to optimize energy consumption across various domains such as smart buildings, industrial systems, smart grids, and renewable energy. Students will learn how to use machine learning and deep learning models to analyze consumption data, predict future usage, and automate control for improved efficiency and sustainability.					
Course Objective	This course aims to impart practical knowledge in applying AI methods for optimizing energy usage, with a focus on reducing energy waste, maximizing efficiency, and integrating sustainable technologies through experiential learning.					
Course Outcomes	Course Outcomes On successful completion of this course, students will be able to: Understand the fundamentals of energy consumption systems and optimization methods. (Understand) Apply AI models to forecast and control energy usage. (Apply) Analyze and derive insights from energy data for efficient decision-making. (Analyze)					

	Design intelligent energy optimization systems using modern AI tools. (Create)

Course Content:

Module 1	Introduction to Energy Systems and Optimization	Assignment		18[8L+10P] Sessions

Topics:

Basics of energy generation, transmission, and consumption,Key challenges in energy optimization, Overview of smart energy systems and IoT integration,Fundamentals of optimization: cost, usage, scheduling

Module 2	Machine Learning for Energy Forecasting	Assignment		14[7L+7P] Sessions

Topics:

Energy datasets and data preprocessing, Regression techniques for load and usage prediction, Time-series modeling with ARIMA and LSTM, Evaluation metrics and model selection

Module 3	Deep Learning and Reinforcement Learning for Energy Control	Assignment		14[6L+8P] Sessions

Topics:

Neural networks for pattern recognition in energy data, Deep learning for anomaly detection, Reinforcement learning for energy-efficient control systems, AI in smart HVAC and lighting systems

Module 4	Applications and Emerging Trends	Assignment		14[6L+8P] Sessions

Topics:

AI in smart homes and smart cities,Integration with renewable energy sources, Case studies: AI in smart grids, buildings, and industry, Future trends: Edge AI, Federated learning in energy networks

Project work/Assignment:

Develop a forecasting model for household energy optimization,Implement an RL-based agent to control energy consumption in a simulated environment, Design a smart energy dashboard with real-time analytics

List of Lab Tasks:

Lab 1: Load and explore energy consumption datasets (e.g., UCI, OpenEI)

Lab 2: Clean and preprocess data for modeling

Lab 3: Build a linear regression model for consumption forecasting Lab 4: Apply decision tree and random forest for energy classification Lab 5: Implement an ARIMA model for time-series analysis Lab 6: Develop a deep learning (LSTM) model for energy prediction Lab 7: Perform anomaly detection on smart meter data Lab 8: Develop a clustering model to group usage patterns Lab 9: Design a dashboard for visualizing real-time and historical energy data Lab 10: Build a rule-based control system for smart appliances Lab 11: Implement Q-learning for controlling a simulated thermostat Lab 12: Reinforcement learning for lighting system optimization Lab 13: Forecast solar energy generation using weather and usage data Lab 14: Combine IoT data with AI models for intelligent decision-making Lab 15: Final capstone: Smart energy optimization prototype using AI
REFERENCE MATERIALS TEXTBOOKS Abhishek Kumar, Machine Learning and Data Science in the Energy Sector, Wiley, 2022. Peter Palensky et al., Energy Informatics: Fundamentals and Applications, Springer, 2021. REFERENCES Soteris Kalogirou, Artificial Intelligence in Energy and Renewable Energy Systems, Nova Science Publishers, 2013. Klaus-Dieter Thoben et al., AI Methods for Smart Energy Systems and Industry 4.0, Springer, 2020. Subramanian Vadari, Smart Grid Redefined: Transformation of the Electric Utility, CRC Press, 2020. JOURNALS / MAGAZINES IEEE Transactions on Smart Grid Energy and AI (Elsevier) Renewable & Sustainable Energy Reviews SWAYAM/NPTEL/MOOCs NPTEL – Smart Grid Technology by IIT Kharagpur Coursera – AI for Energy edX – Data Science and Machine Learning for Energy Systems

Course Code: CAI3420	Course Title: Bio Medical Informatics Type of Course: Integrated	L- P- T-C	2	0	2	3

Version No.	1.0
Course Pre-requisites	CSE2264
Anti-requisites	NIL
Course Description	This course introduces students to Bio Medical Informatics. The focus is on understanding domain-specific data and AI methods applicable to healthcare. The course includes both theoretical and practical components that prepare students for real-world applications in the health sector.
Course Objective	The objective of the course is SKILL DEVELOPMENT of students using EXPERIENTIAL LEARNING techniques.
Course Out Comes	On successful completion of the course the students shall be able to: On successful completion of the course the students shall be able to: CO1: Describe the scope and importance of Bio Medical Informatics. [Understand] CO2: Identify and pre-process health-related data for analysis. [Apply] CO3: Build intelligent models to support medical diagnostics or analytics. [Apply] CO4: Evaluate AI models for performance and reliability in healthcare. [Analyze] CO5: Design ethical, efficient AI-based systems for healthcare applications. [Create]
Course Content:	

Module 1	Introduction to Bio Medical Informatics	Assignment	Program activity	22 Hours

This module introduces the fundamental concepts of Bio Medical Informatics, outlining its scope and significance in modern healthcare. Students will learn about the different types of biomedical data including structured, semi-structured, and unstructured formats. The role of information systems such as Electronic Health Records (EHRs) and medical standards like ICD, SNOMED CT, and HL7 will be discussed. The application of data science and AI in areas such as diagnostics, treatment planning, and clinical workflows will be explored through real-world use cases. This module sets the foundation for understanding how informatics bridges technology and medicine.

Module 2	Data collection, preprocessing techniques and AI model design	Assignment	Program activity	22 Hours s

In this module, the focus shifts to data acquisition and preprocessing techniques essential for biomedical data analysis. Students will explore various data collection methods used in healthcare, including clinical trials, IoT-based sensors, and surveys. Key topics include data cleaning, integration of heterogeneous sources, handling missing values, and feature engineering for biomedical signals and images. Privacy concerns and de-identification practices in patient data will also be addressed. Practical exposure to preprocessing tools and techniques will prepare students for effective data handling in real-world scenarios.

Module 3	Model training, validation, interpretation, and performance metric	Assignment	Program activity	18 Hours

This module delves into the application of machine learning algorithms within the biomedical context. Students will implement supervised learning methods such as logistic regression, decision trees, and support vector machines, along with unsupervised techniques like clustering for patient stratification. Emphasis will be placed on performance evaluation using metrics tailored to healthcare (e.g., sensitivity, specificity, AUC). Techniques for improving model robustness, including cross-validation and model interpretability tools like SHAP and LIME, will be discussed. Real-life datasets will be used to build disease prediction models, offering insights into practical implementation challenges.

Module 4	Deployment, ethics in AI for healthcare, and case studies	Assignment	Program activity	13 Hours

The final module focuses on deploying AI models in clinical environments and understanding the ethical, legal, and social implications of Bio Medical Informatics. Students will learn about lightweight deployment tools such as Flask and Streamlit for building user interfaces and dashboards. Case studies on clinical decision support systems (CDSS) will illustrate the integration of AI into healthcare systems. The module also explores recent trends such as personalized medicine, genomic data analysis, and the role of AI in epidemiology. Ethical dilemmas, bias mitigation, and fairness in AI applications are also critically examined to ensure responsible use of technology in healthcare.

List of Lab Tasks:

Lab Sheet 1: Introduction to healthcare datasets using Python; Data visualization using matplotlib and seaborn

Lab Sheet 2: Data cleaning techniques; Feature selection methods for health data

Lab Sheet 3: Logistic regression for disease prediction; Evaluate with confusion matrix

Lab Sheet 4: Decision trees and random forests; Cross-validation comparisons

Lab Sheet 5: Clustering with K-means; Hierarchical clustering

Lab Sheet 6: Time series forecasting with ARIMA; Anomaly detection

Lab Sheet 7: Genomic sequence preprocessing; Feature extraction

Lab Sheet 8: Medical image preprocessing; CNN classification (e.g., chest X-rays)

Lab Sheet 9: NLP on clinical notes; Named Entity Recognition

Lab Sheet 10: SHAP/LIME interpretability; Deployment with Flask/Streamlit Lab Sheet 11: Dashboard design; Integration with cloud or mobile apps Lab Sheet 12: Bias detection and mitigation Lab Sheet 13: COVID-19 case study; Real-time data visualizatio
Targeted Application & Tools that can be used Python, scikit-learn, pandas, matplotlib, seaborn, Jupyter, TensorFlow/PyTorch, Streamlit
Project work/Assignment:
Assignment: Assignments include module-wise exercises and real-world project implementation.
Text Book T1: Adam Bohr & Kaveh Memarzadeh – Artificial Intelligence in Healthcare, Academic Press, 2020 T2: Kevin Franks – Machine Learning for Healthcare, Apress, 2022
References R1: Recent journal articles from IEEE, Nature, and PubMed R2: Online materials from NPTEL, CourseraWeb resources:
Topics relevant to development of “Skill Development”: Health informatics, AI modeling, data analytics Topics relevant to development of “Environment and sustainability: Public health data analysis, epidemiology

Course Code: CAI3421	Course Title: Intelligent System for Disease Prediction and Drug Discovery Type of Course: Integrated	L- P- T-C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	CSE2264					
Anti-requisites	NIL					
Course Description	This course provides in-depth understanding and hands-on exposure to advanced techniques in Intelligent System for Disease Prediction and Drug Discovery. It aims to enhance technical skills for solving complex problems in healthcare using AI.					

Course Objective	The objective of the course is SKILL DEVELOPMENT of students using EXPERIENTIAL LEARNING techniques.			
Course Out Comes	On successful completion of the course the students shall be able to: On successful completion of the course the students shall be able to: CO1: Describe the scope and role of intelligent systems in disease prediction and drug discovery. [Understand] CO2: Identify and prepare relevant clinical and molecular data for AI model development. [Apply] CO3: Build machine learning and deep learning models for disease prediction and drug target identification. [Apply] CO4: Evaluate the effectiveness of AI models using appropriate metrics in healthcare settings. [Analyze] CO5: Design and propose intelligent, ethical systems for real-world clinical and pharmaceutical applications. [Create]			
Course Content:				
Module 1	Fundamentals of Intelligent Systems in Healthcare	Assignment	Program activity	22 Hours
This module introduces students to the fundamentals of intelligent systems and their significance in disease prediction and drug discovery. It covers knowledge-based systems, expert systems, and decision support systems with examples from clinical settings. Students learn how AI mimics human reasoning for healthcare applications and the use of knowledge engineering in rule-based diagnosis.				
Module 2	Data-Driven Approaches in Disease Prediction	Assignment	Program activity	22 Hours s
The focus here is on data-driven intelligent systems using machine learning and deep learning. It covers data acquisition from clinical databases, molecular and drug databases, and preprocessing techniques suitable for biological data. Techniques for classifying disease patterns and identifying drug targets using AI are discussed.				
Module 3	AI in Computational Drug Discovery	Assignment	Program activity	18 Hours
This module delves into computational drug discovery, covering ligand-based and structure-based approaches. Students explore QSAR modeling, molecular docking, and neural networks for compound activity prediction. Ethical concerns and challenges in in-silico trials are also introduced.				
Module 4	Integration and Applications in Clinical Workflows	Assignment	Program activity	13 Hours
The final module addresses the integration of intelligent systems in clinical workflows and pharmaceutical research. Topics include AI-based platforms for precision medicine, clinical				

validation, regulatory compliance, and case studies on successful AI-driven drug discovery pipelines.

List of Lab Tasks:

Lab Sheet 1

Level 1: Introduction to healthcare and molecular datasets

Level 2: Data loading and exploration using Python (pandas, NumPy)

Lab Sheet 2

Level 1: Data cleaning and preprocessing (missing values, normalization)

Level 2: Feature selection for clinical and drug datasets

Lab Sheet 3

Level 1: Implementation of classification models (Logistic Regression, Decision Trees)

Level 2: Model evaluation using confusion matrix and ROC-AUC

Lab Sheet 4

Level 1: Application of deep learning models for disease prediction

Level 2: Hyperparameter tuning and performance comparison

Lab Sheet 5

Level 1: Introduction to molecular representations (SMILES, fingerprints)

Level 2: Compound similarity calculation and clustering

Lab Sheet 6

Level 1: QSAR modeling using regression techniques

Level 2: Interpretation of chemical descriptors and activity prediction

Lab Sheet 7

Level 1: Structure-based drug discovery: basics of molecular docking

Level 2: Running docking simulations using open-source tools (e.g., AutoDock)

Lab Sheet 8

Level 1: Development of a basic rule-based expert system for disease diagnosis

Level 2: Knowledge base and inference engine simulation

Lab Sheet 9

Level 1: Data visualization with seaborn and matplotlib

Level 2: Creating dashboards to visualize model predictions

Lab Sheet 10

Level 1: Ethical case study analysis in AI-driven healthcare

Level 2: Design of fairness-aware AI models for drug discovery

Lab Sheet 11–15

Capstone mini-project development based on real-world data

Includes problem definition, data handling, model building, evaluation, and report writing

Targeted Application & Tools that can be used Python, scikit-learn, pandas, matplotlib, seaborn, Jupyter, TensorFlow/PyTorch, Streamlit
Project work/Assignment:
Assignment: Assignments include module-wise exercises and real-world project implementation.
Text Book T1: Adam Bohr & Kaveh Memarzadeh – Artificial Intelligence in Healthcare, Academic Press, 2020 T2: Kevin Franks – Machine Learning for Healthcare, Apress, 2022
References R1: Krittanawong, C., Johnson, K.W., Rosenson, R.S., et al. Deep learning for cardiovascular medicine: A practical primer. European Heart Journal, 2020. R2: Ekins, S., Puhl, A.C., Zorn, K.M., et al. Exploiting machine learning for end-to-end drug discovery and development. Nature Materials, 2019. R3: Topol, E. Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again. Basic Books, 2019. Web resources: R4: NPTEL Course – AI for Drug Discovery and Healthcare, https://nptel.ac.in R5: Coursera Specialization – AI in Healthcare Specialization, Stanford University, https://coursera.org
Topics relevant to development of “Skill Development”: Development of classification and regression models Topics relevant to development of “Environment and sustainability: Reduction of animal testing through AI-based drug screening and in-silico trials

Course Code: CAI3422	Course Title: AI for Medical Imaging Type of Course: Integrated	L- P- T- C	2	0	2	3
Version No.	1.0					

Course Pre-requisites	CSE2264			
Anti-requisites	NIL			
Course Description	This course focuses on applying artificial intelligence and deep learning to medical image analysis. Students will explore medical imaging modalities, preprocessing techniques, computer vision models, and deployment strategies. Emphasis is placed on real-world applications such as disease diagnosis, image segmentation, and anomaly detection.			
Course Objective	The objective of the course is SKILL DEVELOPMENT of students using EXPERIENTIAL LEARNING techniques..			
Course Out Comes	On successful completion of the course the students shall be able to: CO1: Describe different medical imaging modalities and AI applications. [Understand] CO2: Preprocess and annotate medical images for AI pipelines. [Apply] CO3: Build and train computer vision models for disease detection. [Apply] CO4: Evaluate performance of AI models using imaging metrics. [Analyze] CO5: Design and deploy ethical and explainable AI solutions in medical imaging. [Create]			
Course Content:				
Module 1	Medical Imaging Modalities and Preprocessing	Assignment	Program activity	22 Hours
This module covers the foundations of medical imaging modalities such as X-rays, CT, MRI, and ultrasound. Students are introduced to DICOM formats, imaging physics, and image acquisition principles. The importance of image preprocessing for AI applications is emphasized.				
Module 2	Deep Learning for Image Analysis	Assignment	Program activity	22 Hours s
Focus is placed on computer vision and deep learning techniques in imaging. Key concepts include convolutional neural networks (CNNs), image segmentation, classification, and detection. Hands-on exercises include building image classification models for disease identification.				
Module 3	Advanced Imaging Techniques and Evaluation	Assignment	Program activity	18 Hours
Advanced topics such as 3D imaging, multi-modal fusion, and transfer learning are covered. Students also explore annotation tools, dataset creation, and model performance metrics like Dice coefficient and IoU.				
Module 4	Deployment and Real-world Applications	Assignment	Program activity	13 Hours

This module discusses AI deployment in radiology workflows, regulatory and ethical considerations, and real-world implementation. Use cases like tumor detection, fracture analysis, and pneumonia prediction are analyzed for impact and accuracy.

List of Lab Tasks:

Lab Sheet 1

Level 1: Loading and visualizing medical images (DICOM, PNG, JPEG) using Python libraries (e.g., pydicom, OpenCV)

Level 2: Image enhancement techniques such as histogram equalization, denoising, and contrast adjustment

Lab Sheet 2

Level 1: Image annotation using tools like LabelImg or CVAT

Level 2: ROI (Region of Interest) extraction and mask creation for segmentation tasks

Lab Sheet 3

Level 1: Building a basic Convolutional Neural Network (CNN) for classifying binary medical images

Level 2: Fine-tuning pretrained models (e.g., VGG16, ResNet) on a labeled medical image dataset

Lab Sheet 4

Level 1: Semantic segmentation using U-Net architecture

Level 2: Evaluation using IoU and Dice coefficient

Lab Sheet 5

Level 1: Multi-class classification with medical datasets (e.g., chest X-ray with normal, pneumonia, COVID-19 labels)

Level 2: Performance evaluation using confusion matrix, sensitivity, specificity, and ROC-AUC

Lab Sheet 6

Level 1: Heatmap generation for explainability using Grad-CAM

Level 2: Visual interpretation of model decisions in medical diagnosis

Lab Sheet 7

Level 1: 3D image visualization using volumetric data (CT/MRI) with SimpleITK

Level 2: Slice-wise analysis and conversion between formats (e.g., NIfTI to PNG)

Lab Sheet 8

Level 1: Building a simple web interface using Streamlit for AI-based image diagnosis

Level 2: Deployment and testing of the model in the interface

Lab Sheet 9

Level 1: Comparative study of model performance with and without data augmentation

Level 2: Real-world use case: early detection of breast cancer using mammography

Lab Sheet 10

Capstone Project: End-to-end implementation of an AI model for a medical imaging problem (e.g., lung opacity classification, brain tumor segmentation, or fracture detection

Targeted Application & Tools that can be used

Programming Language: Python

Deep Learning Frameworks: TensorFlow, Keras, PyTorch

Computer Vision Libraries: OpenCV, PIL (Python Imaging Library)

Medical Image Processing: pydicom, nibabel, SimpleITK

Annotation Tools: LabelImg, CVAT, VGG Image Annotator (VIA)

Visualization: Matplotlib, Seaborn, Grad-CAM for explainability

Model Deployment: Streamlit, Flask

Datasets: NIH Chest X-ray, COVID-19 Radiography Dataset, BraTS for brain tumor segmentation, LIDC-IDRI

Project work/Assignment:

Assignment: Assignments include module-wise exercises and real-world project implementation.

Text Book

T1: Adam Bohr & Kaveh Memarzadeh, Artificial Intelligence in Healthcare, Academic Press, 2020.

T2: S. Kevin Zhou, Hayit Greenspan, Dinggang Shen, Deep Learning for Medical Image Analysis, Academic Press, 2017.

References

R1: M. A. Haidekker, Medical Imaging Technology, Springer, 2013.

R2: Geert Litjens et al., A survey on deep learning in medical image analysis, Medical Image Analysis, Elsevier, 2017.

R3: Online resources including Coursera’s AI for Medical Diagnosis, Stanford’s CS231n: Convolutional Neural Networks for Visual Recognition, and NPTEL’s Medical Image Computing

Web resources:

https://www.coursera.org/learn/ai-for-medical-diagnosis – AI for Medical Diagnosis by DeepLearning.AI

https://cs231n.stanford.edu/ – CS231n: Convolutional Neural Networks for Visual Recognition, Stanford University

https://nptel.ac.in/courses/106/106/106106213/ – Medical Image Computing, NPTEL

https://www.kaggle.com/datasets – Public datasets for medical image classification and segmentation

https://grand-challenge.org/ – AI challenges and annotated datasets for medical imaging research

Topics relevant to development of “Skill Development”: Image preprocessing and augmentation techniques Design and training of deep learning models for medical image classification and segmentation Evaluation of AI models using healthcare-specific metrics (e.g., sensitivity, specificity, IoU, Dice score) Interpretation of model predictions using explainability tools (e.g., Grad-CAM) Building and deploying real-time diagnostic tools using Python, Streamlit, and cloud platforms Collaborative problem-solving through project-based learning with real medical datasets Topics relevant to development of “Environment and sustainability: Use of AI to reduce redundant imaging procedures, minimizing patient exposure to radiation and resource use Energy-efficient model architectures and deployment practices to lower computational footprint in healthcare AI Early detection and screening with AI to reduce the need for invasive follow-up procedures and hospital admissions Cost-effective diagnostic solutions that support equitable access to healthcare in under-resourced or rural areas Adoption of paperless workflows and digital tools to support green healthcare initiatives

Course Code: CAI3423	Course Title: Genomic Data Science Type of Course: Integrated	L- P- T- C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	CSE2264					
Anti-requisites	NIL					
Course Description	This course provides an in-depth understanding of genomic data and the computational approaches used to analyze it. Students will explore genome structures, sequencing technologies, data preprocessing techniques, and the application of machine learning and statistical tools for interpreting genomic data. The course aims to equip students with the skills needed to extract meaningful insights from genomic datasets for biomedical and healthcare applications.					
Course Objective	The objective of the course is SKILL DEVELOPMENT of students using EXPERIENTIAL LEARNING techniques.					

Course Out Comes	On successful completion of the course the students shall be able to: CO1: Describe fundamental genomic concepts and technologies. [Understand] CO2: Preprocess and manage large-scale genomic datasets. [Apply] CO3: Apply bioinformatics and ML techniques to genomic data. [Apply] CO4: Analyze and interpret patterns in gene expression and sequence data. [Analyze] CO5: Design solutions for personalized healthcare using genomic insights. [Create]			
Course Content:				
Module 1	Introduction to Genomics and Data Sources	Assignment	Program activity	22 Hours
An introduction to the field of genomics and its role in personalized medicine forms the basis of this module. Topics include genome structure, sequencing technologies, types of genomic data, and public genomic databases such as ENSEMBL, NCBI, and 1000 Genomes.				
Module 2	Genomic Data Preprocessing and Feature Engineering	Assignment	Program activity	22 Hours s
Students learn to handle large-scale genomic data, including sequence alignment (BLAST, BWA), variant calling (VCF), and gene expression analysis (microarray, RNA-seq). Focus is also given to quality control, normalization, and handling missing values.				
Module 3	Machine Learning in Genomic Analysis	Assignment	Program activity	18 Hours
Machine learning approaches are applied to tasks such as disease susceptibility prediction, biomarker discovery, and patient stratification. Techniques include classification, clustering, and feature selection using scikit-learn and bioinformatics tools like BioPython and Bioconductor.				
Module 4	Applications in Personalized Medicine	Assignment	Program activity	13 Hours
This module explores case studies in cancer genomics, pharmacogenomics, and population genomics. Ethical considerations, data privacy (e.g., HIPAA, GDPR), and the integration of genomic data into clinical workflows are discussed.				
List of Lab Tasks: Lab Sheet 1 Level 1: Retrieve DNA and protein sequences from NCBI and Ensembl databases Level 2: Visualize and annotate genomic regions using the UCSC Genome Browser Lab Sheet 2 Level 1: Perform sequence alignment using BLAST (Basic Local Alignment Search Tool)				

Level 2: Use BWA (Burrows-Wheeler Aligner) for short-read alignment; convert to SAM/BAM formats Lab Sheet 3 Level 1: Variant calling from aligned reads using bcftools or GATK Level 2: Annotate variants using tools like VEP (Variant Effect Predictor) or SnpEff Lab Sheet 4 Level 1: Preprocess microarray gene expression data (normalization, filtering) Level 2: Perform RNA-seq pipeline: FASTQ to aligned reads and read counts Lab Sheet 5 Level 1: Feature engineering: convert genomic data into machine learning-ready formats Level 2: Apply dimensionality reduction (PCA, t-SNE) on gene expression datasets Lab Sheet 6 Level 1: Train a simple classifier (e.g., SVM, Decision Tree) to predict disease from gene expression Level 2: Evaluate model performance using accuracy, precision, recall, and AUC Lab Sheet 7 Level 1: Cluster genomic samples using k-means and hierarchical clustering Level 2: Visualize clusters using heatmaps and dendrograms Lab Sheet 8–10 Capstone Project: Use genomic datasets to identify candidate biomarkers or predict disease risk; includes full workflow from data preprocessing to model evaluation and report presentation
Targeted Application & Tools that can be used Data Repositories: NCBI, Ensembl, 1000 Genomes Project, UCSC Genome Browser Sequence Analysis: BLAST, BWA, SAMtools, FASTQC Variant Calling & Annotation: bcftools, GATK, VEP, SnpEff Gene Expression Analysis: DESeq2, edgeR (via R/Bioconductor), limma Machine Learning Libraries: scikit-learn, TensorFlow, XGBoost Bioinformatics Libraries: BioPython, Bioconductor (R), pyVCF Visualization: matplotlib, seaborn, pheatmap, genome browsers Web Platforms: Galaxy, EMBL-EBI Tools Environments: Jupyter Notebook, RStudio, Google Colab
Project work/Assignment:
Assignment: Assignments include module-wise exercises and real-world project implementation.
Text Book T1: Michael C. Schatz et al., Genomic Data Science, Cold Spring Harbor Lab Press, 2022

T2: Jason H. Moore & Scott M. Williams, Bioinformatics for Geneticists, Wiley, 2020
References R1: R. Durbin et al., Biological Sequence Analysis, Cambridge University Press, 1998 R2: Online resources from Coursera (e.g., Genomic Data Science Specialization by Johns Hopkins), NPTEL, and EMBL-EBI Web resources: https://www.ncbi.nlm.nih.gov/ – NCBI Genomics Portal https://www.ensembl.org/ – Ensembl Genome Browser https://galaxyproject.org/ – Web-based bioinformatics analysis platform https://bioconductor.org/ – Open software for genomic data analysis
Topics relevant to development of “Skill Development”: Genome browsing and data retrieval Variant analysis and functional annotation Machine learning applications in genomics Development of predictive models using omics data Project-based learning with publicly available datasets Topics relevant to development of “Environment and sustainability: Use of genomics to develop sustainable agriculture and precision nutrition Minimizing clinical trial waste through AI-based patient stratification Genetic screening for early disease detection to reduce long-term healthcare burden Efficient use of cloud computing for large-scale genomic data analysis

Course Code: CAI3424	Course Title: Clinical Data Science Type of Course: Integrated	L- P- T-C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	CSE2264					
Anti-requisites	NIL					
Course Description	This course introduces students to clinical data and the computational methods used for its analysis in healthcare. The curriculum covers electronic health records (EHR), clinical coding systems, data preprocessing, predictive modeling, and visualization. Students gain skills in transforming raw clinical data into meaningful insights for improving patient outcomes and supporting evidence-based decision-making.					

Course Objective	The objective of the course is SKILL DEVELOPMENT of students using EXPERIENTIAL LEARNING techniques.			
Course Out Comes	On successful completion of the course the students shall be able to: CO1: Describe clinical data sources, structures, and standards. [Understand] CO2: Preprocess and integrate structured and unstructured clinical data. [Apply] CO3: Build analytical models for clinical decision support. [Apply] CO4: Evaluate model accuracy and interpret outputs using relevant metrics. [Analyze] CO5: Design data-driven solutions for real-world healthcare scenarios. [Create]			
Course Content:				
Module 1	Introduction to Clinical Data and Coding Systems	Assignment	Program activity	22 Hours
This module introduces electronic health records (EHRs), their components, and commonly used clinical coding systems like ICD, CPT, and LOINC. Students understand how structured and unstructured clinical data are generated and stored in hospitals and research environments.				
Module 2	Clinical Data Processing and Integration	Assignment	Program activity	22 Hours s
Focuses on data cleaning, missing value handling, temporal sequencing, and merging data from disparate hospital systems. Students explore preprocessing tools such as pandas and SQL, with real-world clinical datasets for practice.				
Module 3	Predictive Analytics and Risk Modeling	Assignment	Program activity	18 Hours
Students learn to develop and evaluate machine learning models for predicting hospital readmissions, disease progression, and patient risk scores. Survival analysis and calibration techniques are introduced.				
Module 4	Visualization and Deployment in Clinical Workflows	Assignment	Program activity	13 Hours
Covers best practices for visualizing clinical KPIs, creating dashboards for hospital use, and regulatory requirements like HIPAA and HL7 compliance. Students build real-time reporting tools for clinical insights.				
List of Lab Tasks: Lab Sheet 1				

Level 1: Explore the structure of synthetic electronic health records (EHRs) Level 2: Extract and visualize demographic information using SQL or pandas Lab Sheet 2 Level 1: Preprocess structured clinical data: handle missing values, outliers Level 2: Transform unstructured clinical notes using basic NLP (e.g., tokenization, stemming) Lab Sheet 3 Level 1: Join and merge multi-source clinical datasets (e.g., labs + diagnosis + medication) Level 2: Time-based filtering and patient cohort generation using temporal queries Lab Sheet 4 Level 1: Build a logistic regression model to predict hospital readmission Level 2: Evaluate model performance using confusion matrix and ROC curve Lab Sheet 5 Level 1: Perform survival analysis using Kaplan-Meier estimator Level 2: Cox proportional hazards model to analyze patient survival risk Lab Sheet 6 Level 1: Create a visual dashboard of patient metrics using tools like matplotlib or seaborn Level 2: Build a real-time monitoring dashboard with Streamlit Lab Sheet 7–10 Capstone Project: End-to-end clinical analytics project: data preprocessing, modeling, evaluation, and reporting using real-world or simulated data
Targeted Application & Tools that can be used Data Repositories & Formats: MIMIC-III, eICU, FHIR, CSV, HL7 Programming & Data Handling: Python, SQL, pandas, NumPy Data Visualization: matplotlib, seaborn, Plotly, Streamlit Machine Learning Frameworks: scikit-learn, XGBoost Survival Analysis: Lifelines (Python), R survival package NLP for Clinical Text: spaCy, NLTK, SciSpacy Dashboards & Reporting: Power BI, Streamlit, Tableau (optional) Environment: Jupyter Notebook, Google Colab, Anaconda
Project work/Assignment:
Assignment: Assignments include module-wise exercises and real-world project implementation.
Text Book T1: Mark L. Braunstein, Practitioner's Guide to Health Informatics, Springer, 2015.

T2: Pradeep Menon, Applied Clinical Informatics: A Practical Guide for Healthcare Professionals, CRC Press, 2021.
References R1: J. D. Dalianis, Clinical Text Mining: Secondary Use of Electronic Patient Records, Springer, 2018. R2: Steinar Carlsen et al., Health Informatics: An Interprofessional Approach, Elsevier, 2020. R3: Online resources including MIMIC-III tutorials (MIT-LCP), NPTEL Health Analytics courses, and Coursera's Data Science in Stratified Healthcare and Precision Medicine. Web resources: https://physionet.org/about/mimic/ – MIMIC-III: Medical Information Mart for Intensive Care https://www.hl7.org/ – Health Level Seven International (HL7 standards) https://nptel.ac.in/courses/106/106/106106213 – NPTEL: Health Informatics and Analytics https://www.coursera.org/learn/clinical-data-science – Coursera: Clinical Data Science Specialization https://streamlit.io/ – Streamlit: Rapid development of clinical data dashboards
Topics relevant to development of "Skill Development": Handling and preprocessing large-scale clinical datasets (structured and unstructured) Using SQL and Python for real-world healthcare data analysis Developing predictive models for risk scoring and clinical decision support Conducting survival analysis and time-to-event modeling Visualizing healthcare data using professional dashboard tools Building real-time, interactive applications for clinical reporting and monitoring Applying NLP techniques for extracting information from clinical notes Topics relevant to development of "Environment and sustainability: Promoting data-driven, paperless clinical workflows for sustainable healthcare management Reducing unnecessary diagnostic procedures through predictive analytics Enhancing resource optimization in hospitals via data-informed decision-making Supporting public health sustainability through early risk detection and preventive care models Minimizing environmental burden by deploying digital dashboards and remote monitoring systems

Course Code: CAI3425	Course Title: AI in Epidemiology and Public Health Analytics Type of Course: Integrated	L- P- T-C	2	0	2	3

Version No.	1.0			
Course Pre-requisites	CSE2264			
Anti-requisites	NIL			
Course Description	This course explores how artificial intelligence can be applied in epidemiology and public health to understand, predict, and manage health outcomes at a population level. Students will gain skills in analyzing health indicators, working with public datasets, and developing AI-based models for forecasting outbreaks and informing health policy decisions			
Course Objective	The objective of the course is SKILL DEVELOPMENT of students using EXPERIENTIAL LEARNING techniques.			
Course Out Comes	On successful completion of the course the students shall be able to: CO1: Explain the principles of epidemiology and population health data. [Understand] CO2: Preprocess and analyze large-scale public health datasets. [Apply] CO3: Develop AI models for outbreak prediction and risk estimation. [Apply] CO4: Evaluate model outcomes for public health decision-making. [Analyze] CO5: Design data-driven tools and dashboards for health policy and surveillance. [Create]			
Course Content:				
Module 1	Foundations of Epidemiology and Health Indicators	Assignment	Program activity	22 Hours
Introduces the core concepts of epidemiology including incidence, prevalence, mortality, morbidity, and health surveillance systems. Students learn about the structure and utility of public health datasets such as NHANES, DHS, and WHO databases.				
Module 2	Public Health Data Analytics	Assignment	Program activity	22 Hours s
Focuses on collecting, cleaning, and analyzing epidemiological data using statistical and AI tools. Students apply descriptive analytics and GIS-based visualizations to identify trends and disparities in population health.				
Module 3	AI Models for Population Health Forecasting	Assignment	Program activity	18 Hours

Students build predictive models for disease outbreak forecasting, disease burden estimation, and vaccination coverage prediction using machine learning algorithms like decision trees, SIR models, and ensemble methods.				
Module 4	Visualization and Ethical Implications in Public Health AI	Assignment	Program activity	13 Hours
Students develop dashboards and visual reports to support public health decision-making. The module also explores privacy, fairness, and ethical issues in population-level AI applications.				

List of Lab Tasks:

Lab Sheet 1

Level 1: Load and explore public health datasets (e.g., NHANES, DHS)

Level 2: Perform descriptive statistical analysis (mean, median, incidence rates)

Lab Sheet 2

Level 1: Clean and preprocess public health data using pandas

Level 2: Perform demographic segmentation and cohort analysis

Lab Sheet 3

Level 1: Visualize disease distribution geographically using plotly or geopandas

Level 2: Create choropleth maps and interactive visualizations

Lab Sheet 4

Level 1: Train a decision tree or logistic regression model to classify health risk groups

Level 2: Evaluate classification performance using ROC and precision-recall curves

Lab Sheet 5

Level 1: Apply time series forecasting (e.g., ARIMA) to model disease trends

Level 2: Compare model forecasts with actual data using RMSE

Lab Sheet 6

Level 1: Implement a simple SIR model to simulate disease spread

Level 2: Calibrate parameters to fit real-world outbreak data

Lab Sheet 7

Level 1: Build a public health dashboard using Streamlit

Level 2: Integrate multiple charts and summary statistics into an interactive interface

Lab Sheet 8–10

Capstone Project: Design an AI-based early warning system or policy dashboard using historical epidemic or immunization data

Targeted Application & Tools that can be used

Public Health Datasets: NHANES, DHS, WHO Global Health Observatory, India NFHS

Programming & Analysis: Python, pandas, NumPy, SciPy, statsmodels Visualization: matplotlib, seaborn, plotly, geopandas, folium AI/ML Frameworks: scikit-learn, XGBoost, Prophet, TensorFlow (optional) Epidemiological Modeling: SIR/SEIR models using custom Python functions Geospatial Mapping: QGIS (optional), plotly choropleths, mapbox Dashboards & Reporting: Streamlit, Tableau (optional), Power BI Environments: Jupyter Notebook, Google Colab, Anaconda
Project work/Assignment:
Assignment: Assignments include module-wise exercises and real-world project implementation.
Text Book T1: Michael J. Paul & Mark Dredze, Social Monitoring for Public Health, Morgan & Claypool, 2017. T2: R. Bonita, R. Beaglehole & T. Kjellström, Basic Epidemiology, 2nd Edition, WHO Press, 2006.
References R1: David L. Streiner & Geoffrey R. Norman, Health Measurement Scales: A Practical Guide to Their Development and Use, Oxford University Press, 2015. R2: Online resources including CDC WONDER database, WHO Health Data Platform, and training modules from Johns Hopkins' Coursera series on Public Health Data Science R3: Tutorials and documentation for SIR/SEIR modeling, GIS-based health data visualization, and epidemiological surveillance dashboards Web resources: https://www.who.int/data – WHO Global Health Observatory (GHO) https://www.cdc.gov/datastatistics – CDC Data & Statistics https://www.coursera.org/specializations/public-health-data-science – Coursera: Public Health Data Science Specialization https://ourworldindata.org/coronavirus – COVID-19 data and public health analysis tools https://www.healthdata.org/ – Institute for Health Metrics and Evaluation (IHME)
Topics relevant to development of “Skill Development”: Epidemiological data cleaning, exploration, and statistical summarization Application of machine learning for disease prediction and outbreak forecasting Use of geospatial tools for mapping and hotspot analysis Development of interactive public health dashboards using real datasets Deployment of AI models for real-time public health monitoring Communication of data-driven insights for policy formulation and community awareness

Topics relevant to development of “Environment and sustainability: Early detection and mitigation of disease outbreaks to reduce public health burden AI-based models to track the impact of climate change on health outcomes Data-driven planning for sustainable healthcare infrastructure and resource allocation Monitoring of environmental hazards (e.g., air/water pollution) and their epidemiological impact Supporting sustainable development goals (SDGs) related to health and well-being (e.g., SDG 3, SDG 6, SDG 13)

Course Code: CAI3426	Course Title: Time Series Analysis for Patient Monitoring Type of Course: Integrated	L- P- T- C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	CSE2264					
Anti-requisites	NIL					
Course Description	This course focuses on time series data generated from continuous patient monitoring systems such as ICU sensors, wearable devices, and medical records. Students will learn to preprocess, analyze, and forecast temporal data using classical and machine learning-based time series models to detect anomalies and predict patient conditions.					
Course Objective	The objective of the course is SKILL DEVELOPMENT of students using EXPERIENTIAL LEARNING techniques.					
Course Out Comes	On successful completion of the course the students shall be able to: CO1: Explain the nature and components of time series data in healthcare. [Understand] CO2: Preprocess and extract meaningful features from patient monitoring data. [Apply] CO3: Build forecasting and anomaly detection models using time series techniques. [Apply] CO4: Evaluate the performance of time series models for clinical applications. [Analyze] CO5: Design intelligent patient monitoring solutions using real-time data streams. [Create]					

Course Content:				
Module 1	Fundamentals of Healthcare Time Series Data	Assignment	Program activity	22 Hours
Introduces sources and structures of time series data in healthcare, such as vital signs, ECG, glucose levels, and ICU telemetry. Covers time series components (trend, seasonality, noise) and visualization techniques.				
Module 2	Time Series Preprocessing and Feature Engineering	Assignment	Program activity	22 Hours s
Focuses on handling missing data, irregular sampling, outliers, normalization, resampling, and windowing. Techniques for extracting rolling statistics and domain-specific temporal features are covered.				
Module 3	Forecasting and Anomaly Detection Models	Assignment	Program activity	18 Hours
Students implement statistical models like ARIMA, SARIMA, and exponential smoothing, as well as ML-based approaches such as LSTM, GRU, and hybrid models. Emphasis is placed on model selection, tuning, and interpretability.				
Module 4	Deployment and Real-time Monitoring Applications	Assignment	Program activity	13 Hours
Covers real-time patient monitoring frameworks, streaming data pipelines, alert systems, and dashboard integration using lightweight deployment tools (e.g., Streamlit, MQTT). Includes ethical and regulatory issues in monitoring.				

List of Lab Tasks:

Lab Sheet 1

Level 1: Load and visualize patient time series data (e.g., heart rate, ECG)

Level 2: Decompose time series into trend, seasonality, and residuals

Lab Sheet 2

Level 1: Handle missing data using interpolation and imputation techniques

Level 2: Resample irregularly spaced data and smooth noisy signals

Lab Sheet 3

Level 1: Extract rolling statistics (mean, std) and domain-specific features (e.g., HRV)

Level 2: Apply time windowing techniques for model input preparation

Lab Sheet 4

Level 1: Build an ARIMA model for forecasting a physiological signal

Level 2: Evaluate model performance using MAE, RMSE, and residual plots

Lab Sheet 5

Level 1: Train an LSTM model for predicting vital signs

Level 2: Tune hyperparameters and visualize learning curves

Lab Sheet 6

Level 1: Detect anomalies in ICU data using Z-score and Isolation Forest

Level 2: Compare detection rates across different methods

Lab Sheet 7

Level 1: Create a real-time streaming simulation using stored sensor data

Level 2: Trigger alerts when predefined clinical thresholds are breached

Lab Sheet 8–10

Capstone Project: Develop an end-to-end patient monitoring pipeline (data ingestion, processing, forecasting, alerting, and visualization)

Targeted Application & Tools that can be used

Programming Languages & Libraries:
Python, pandas, NumPy, matplotlib, seaborn, statsmodels

Time Series & Forecasting:
ARIMA, SARIMA, Holt-Winters, Prophet, scikit-learn, pmdarima

Deep Learning Models:
TensorFlow, Keras, LSTM, GRU, Autoencoders

Anomaly Detection:
Isolation Forest, Z-score, One-Class SVM

Data Visualization & Dashboards:
Plotly, Streamlit, Dash

Healthcare Datasets & Simulators:
MIMIC-III Waveform Database, PhysioNet, openICPSR vital sign data

Streaming & Real-time Tools (optional):
MQTT, Apache Kafka (for advanced setups), Flask for alerting interfaces

Development Environment:
Jupyter Notebook, Google Colab, VS Code

Project work/Assignment:

Assignment: Assignments include module-wise exercises and real-world project implementation.

Text Book

T1: Aileen Nielsen, Practical Time Series Analysis: Prediction with Statistics and Machine Learning, O'Reilly Media, 2019

T2: Paolo Emiliozzi, Time Series Forecasting in Python, Leanpub, 2021

References R1: Rob J. Hyndman & George Athanasopoulos, Forecasting: Principles and Practice, OTexts, 3rd edition (freely available online) R2: Online resources and datasets from https://physionet.org/ – MIMIC, eICU, and waveform databases R3: Tutorials from Coursera's Time Series Forecasting, NPTEL's Healthcare Analytics, and GitHub repositories for clinical time series modeling using LSTM and GRU Web resources: https://physionet.org/ – PhysioNet: Free access to physiological time series datasets (e.g., MIMIC, ECG, ICU signals) https://otexts.com/fpp3/ – Online book: Forecasting: Principles and Practice https://www.coursera.org/learn/time-series – Coursera: Time Series Forecasting Specialization https://github.com/awslabs/gluon-ts – GluonTS: Probabilistic time series modeling with deep learning https://tensorflow.org/tutorials/structured_data/time_series – TensorFlow Time Series tutorials
Topics relevant to development of "Skill Development": Preprocessing and analyzing time series data from patient monitoring systems Building forecasting models using ARIMA, LSTM, and hybrid techniques Detecting anomalies in vital signs and physiological signals Designing end-to-end data pipelines for real-time health monitoring Developing interactive dashboards and alerting systems for clinical decision support Hands-on experience with publicly available ICU and wearable sensor datasets Topics relevant to development of "Environment and sustainability: Reducing unnecessary hospital visits through continuous remote monitoring of patients Promoting sustainable healthcare by enabling early detection and preventive interventions Minimizing resource usage (e.g., tests, ICU beds) through AI-based forecasting and anomaly alerts Supporting environmentally friendly healthcare models by integrating low-power wearable devices Enhancing public health outcomes with minimal ecological impact via digital monitoring platforms

Course Code: CAI3427	Course Title: Language Models for Text Mining Type of Course: Integrated	L-T-P-C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	CSE2264					

<table>
<tr><td>Anti-requisites</td><td colspan="4">NIL</td></tr>
<tr><td>Course Description</td><td colspan="4">This course introduces the basics of Text Mining and Natural Language Processing. The course will teach students different concepts such as text mining, NLP, Sequence Labeling, etc.

Topics: Text Mining, NLP, Tokenization, Lemmatization, Stemming, One-hot encoding, Language modelling, Bag-of-words, Term-document Matrix, Cosine similarity, Viterbi Algorithm, etc.</td></tr>
<tr><td>Course Objectives</td><td colspan="4">The objective of the course is EMPLOYBILITY of student by using EXPERIENTIAL LEARNING techniques.</td></tr>
<tr><td>Course Out Comes</td><td colspan="4">On successful completion of this course the students shall be able to:

Process text data to derive information from text. [Apply]

Apply insights from textual information to real-world business. [Apply]

Develop solutions for a particular NLP problem using different machine learning and deep learning techniques. [Apply]

Utilize different NLP tools and packages. [Apply]</td></tr>
<tr><td colspan="5">Course Content:</td></tr>
<tr><td>Module 1</td><td>Text Mining</td><td>Adversarial Quiz Tests</td><td>Module Tests</td><td>No. of
Sessions: 09</td></tr>
<tr><td colspan="5">Introduction to Text Mining. Text Mining vs. NLP. Text Mining Algorithms. Steps in Text Mining - Extraction, Preprocessing, Analysis and Evaluation. Lexical Resource Creation (NEW). Data collection. String Manipulation to Clean Data. Natural Language Processing. Research Paradigms in NLP. Sequential Data. Sequence Labeling (NEW). Viterbi Algorithm (NEW). Corpus. Building a HMM using a Corpus (NEW). Unknown word handling (NEW).</td></tr>
<tr><td>Module 2</td><td>Text Preprocessing</td><td>Adversarial Quiz Tests</td><td>Module Tests</td><td>No. of
sessions: 06</td></tr>
<tr><td colspan="5">Introduction to Preprocessing. Tokenization. Stop Words Removal. Lemmatization and Stemming. PoS Tagging. Integer Encoding. Padding. One-Hot Encoding.</td></tr>
<tr><td>Module 3</td><td>Text Representations</td><td>Adversarial Quiz Tests</td><td>Module Tests</td><td>No. of
sessions: 08</td></tr>
<tr><td colspan="5">Language Modeling. N-Gram Language Model. Bag-of-Words Model. Term-Document Matrix. Term Frequency. Inverse Document Frequency. TF-IDF. Cosine Similarity. Naive Bayes Classifier using Bag-of-Words. Topic Modeling. Latent Semantic Analysis. Singular Value Decomposition. Truncated SVD and Topic Vector. LDA Algorithm.</td></tr>
<tr><td>Module 4</td><td>Natural Language Processing with Keras</td><td>Adversarial Quiz Tests</td><td>Module Tests</td><td>No. of
Sessions: 06</td></tr>
<tr><td colspan="5">Word Embeddings vs. One-Hot Encoding. Contextual Bag of Words (CBOW). Skipgram. Deep Learning for Document Classification.</td></tr>
<tr><td colspan="5">List of Lab Tasks:

Experiment No. 1: File Handling

Level 1: Read text files using Python and extract meaningful content.</td></tr>
</table>

Level 2: Parse text files using Python to preprocess the data for NLP tasks.

Experiment No. 2: Introduction to NLP Tools

Level 1: Install and use NLTK for basic text processing.

Level 2: Install and use SpaCy for tokenization, PoS tagging, and Named Entity Recognition.

Experiment No. 3: Corpus Cleaning Techniques

Level 1: Use NLTK for corpus cleaning techniques such as tokenization, stopword removal, and stemming.

Level 2: Prepare cleaned text data for downstream NLP tasks like classification or translation.

Experiment No. 4: Word Vector Usage

Level 1: Download and use pre-trained word vectors (e.g., Word2Vec, GloVe, or FastText).

Level 2: Compute similarity between two words, find the most similar word, and complete word analogies (e.g., king - man + woman = queen).

Experiment No. 5 & 6: Language Identification

Level 1: Build a simple language identifier using Bag-of-Words (BoW) features.

Level 2: Predict the language of a given text using the trained model.

Experiment No. 7 & 8: Lexical Simplification

Level 1: Implement a lexical simplifier to replace complex words with simpler alternatives.

Level 2: Generate a simplified version of a given word or sentence while preserving meaning.

Experiment No. 9 & 10: Sentiment Analysis

Level 1: Implement a basic sentiment classifier using a lexicon-based or machine learning approach.

Level 2: Compare the performance of an existing sentiment classifier (e.g., VADER, TextBlob, or a pre-trained Transformer model).

Experiment No. 11: Named Entity Recognition (NER)

Level 1: Extract named entities from a text using NLTK.

Level 2: Extract named entities using SpaCy and compare results.

Experiment No. 12 & 13: Implement a Hidden Markov Model (HMM)

Level 1: Implement a generic HMM for sequence prediction.

Level 2: Calculate the forward probability of a given sequence using HMM.

Experiment No. 14: Linguistic HMM

Level 1: Develop a Hidden Markov Model (HMM) for NLP tasks such as PoS tagging.

Level 2: Evaluate the performance of the HMM on a specific NLP task (e.g., Named Entity Recognition or Chunking).

Experiment No. 15: Machine Translation

Level 1: Implement Machine Translation (MT) using a pre-trained model from Hugging Face Transformers.

Level 2: Evaluate the quality of MT output via Round-Trip Translation (translate text to another language and back to check accuracy).

Targeted Application & Tools that can be used:

Google Colab

Python IDEs like PyCharm

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

Group project on some NLP Task like text classification (Creating a Simple Text Classifier: Use Scikit-learn to classify positive vs. negative reviews from a dataset), sentiment analysis, etc.

Textbook(s):

Daniel Jurafsky, James H. Martin. "Speech and Language Processing: An Introduction to Natural Language Processing", Computational Linguistics and Speech, Pearson Publication, 2025 (3rd Edition Draft).

Aditya Joshi, Pushpak Bhattacharyya. "Natural Language Processing", Wiley Publication, 2023 (1st Edition).

References:

R1. Chris Manning and Hinrich Schutze, "Foundations of Statistical Natural Language Processing", 1st Edition, MIT Press. 1999.

R2. Pawan Goyal. "Natural Language Processing". 1st Edition, 2016.

Weblinks

W1. E-Book link or R2: https://drive.google.com/file/d/10nbwAJd-dv6htOOZVBgAvLd1WscI0RqC/view

W2. Web Resource for T1: https://web.stanford.edu/~jurafsky/slp3/ - VERY VERY IMPORTANT!!!

W3. NPTEL Courses: https://nptel.ac.in/courses/106106211 CMI), https://nptel.ac.in/courses/106105158 (IIT Kgp), https://nptel.ac.in/courses/106101007 (IITB), https://nptel.ac.in/courses/106105572 (IIT Kgp - NEW)

Course Code: CAI3428	Course Title: Practical Deep Learning with TensorFlow Type of Course: Integrated	L- T-P- C	2	0	2	3
Version No.	1.0					

Course Pre-requisites	CSE2264			
Anti-requisites	NIL			
Course Description	This course introduces students to the concepts of deep neural networks and state of the art approaches to develop deep learning models. In this course students will be given an exposure to the details of neural networks as well as deep learning architectures and to develop end-to-end models for such tasks. It will help to design and develop an application-specific deep learning models and also provide the practical knowledge handling and analyzing end user realistic applications.			
Course Objective	This course is designed to improve the learners EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques.			
Course Outcomes	On successful completion of this course the students shall be able to: Implement backpropagation and gradient descent techniques to train neural networks effectively. (Apply) Build and train deep learning models using Python libraries such as TensorFlow and Keras for real-world applications. (Apply) Utilize deep learning techniques for image classification, object detection, sentiment analysis, and language modeling. (Apply)			
Course Content:				
Module 1	Basics of Neural Networks	Assignment		18[8L+10P] Sessions
Topics: Understanding Perceptron with Excel, Understanding Multilayer Perceptron with Excel, From Multilayer Perceptron to Deep Learning, Error Backpropagation and Gradient Descent to reduce errors, Activation Functions, Deep Learning, Problems with Deep Learning with solutions.				
Module 2	TensorFlow Basics	Assignment		14[7L+7P] Sessions
Topics: Introduction to TensorFlow, TensorFlow dataset, Machine Learning with TensorFlow				
Module 3	Deep Learning methods with Tensor Flow and Keras	Assignment		14[6L+8P] Sessions
Topics: Main Features of TensorFlow, Keras basics, AI with Keras.				
Project work/Assignment:				
Assignment 1 on (Module 1 and Module 2) Assignment 2 on (Module 3)				
List of Lab Tasks:				

Lab 1: Working with Deep Learning Frameworks

Objective: Explore various Deep Learning Frameworks

Tasks: Identify deep learning frameworks (Keras, Tensorflow, Matplotlib, etc)

Activity: Practice with various methods available in DL Frameworks to develop a Model.

Lab 2: Build a Basic Artificial Neural Network

Objective: Create a ANN with DL frameworks.

Task: Identify suitable ANN Layers using Keras and Tensorflow.

Activity: Design a basic Artificial Neural Networks using Keras with TensorFlow (pima-indians-diabetes)

Lab 3: Build a MultiLayer Perceptron

Objective: Create a MLP for classification task.

Task: Identify suitable model for house price prediction.

Activity: Design a MLP for implementing classification and fine-tuning using House price.csv

Lab 4: Create a Tensor in TensorFlow using List or Numpy array.

Objective: To understand how to create a tensor in TensorFlow using a Python list or NumPy array

Task: Create a simple tensor using both a Python list and a NumPy array in TensorFlow.

Activity: Create a tensor using a Python list and Numpy array

Lab 5: Apply math operations on tensor using various mathematical functions.

Objective: To learn how to apply mathematical operations on tensors using various TensorFlow mathematical functions.

Task: Perform basic mathematical operations (addition, subtraction, multiplication, division) and advanced functions (square, square root, exponential) on tensors.

Activity: Perform basic math operations: Add, Subtract, Multiply, Divide and Apply advanced math functions: Square, Square root, Exponential.

Lab 6: Connecting two tensors in dataset.

Objective: Combine two tensors using concatenation and stacking operations in TensorFlow.

Task: Combine two tensors using concatenation and stacking operations in TensorFlow

Activity: Concatenate them along a specific axis and Stack them along a new axis.

Lab 7: Building dataset from a file stored in a local drive

Objective: To learn how to build a dataset in TensorFlow from a file stored in a local drive.

Task: Load a dataset from a CSV file stored on the local drive and process it using TensorFlow

Activity: Load the file using TensorFlow’s tf.data API and Process the dataset (e.g., convert it into tensors)

Lab 8: Loading Dataset from TensorFlow.dataset Library

Objective: To learn how to load a dataset from the tensorflow_datasets library and use it in machine learning models.

Task: Load a dataset from TensorFlow Datasets (tfds), preprocess it, and display sample data

Activity: Load a dataset (e.g., MNIST, CIFAR-10, IMDB Reviews) and Split the dataset into training and testing sets.

Lab 9: Build a Convolutional Neural Network

Objective: Create a CNN model.

Task: Build CNN architecture for Dog-Cat classification problem.

Activity: Implement a Convolution Neural Network (CNN) for dog/cat classification problem using keras.

Lab 10: Build a Time-Series Model

Objective: Create a RNN and LSTM Model

Task: Build RNN/LSTM Model for predicting time series data.

Activity Train a sentiment analysis model on IMDB dataset, use RNN layers with LSTM/GRU notes.

REFERENCE MATERIALS:

TEXTBOOKS

François Chollet, “Deep Learning with Python”, 2nd Edition, Manning Publications, 2022

Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2017.

REFERENCES

Amlan Chakrabarti Amit Kumar Das, Saptarsi Goswami, Pabitra Mitra , “Deep Learning”, Pearson Publication, 2021.

David Foster, “Generative Deep Learning” O’Reilly Publishers, 2020.

John D Kellehar, “Deep Learning”, MIT Press, 2020.

JOURNALS/MAGAZINES

IEEE Transactions on Neural Networks and Learning Systems

https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=5962385

IEEE Transactions on Pattern Analysis and Machine Intelligence

https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=34http://ijaerd.com/papers/special_papers/IT032.pdf International Journal of Intelligent Systems https://onlinelibrary.wiley.com/journal/1098111x SWAYAM/NPTEL/MOOCs: Swayam Nptel – Deep Learning – IIT Ropar https://onlinecourses.nptel.ac.in/noc21_cs35/preview Coursera – Neural Networks and Deep Learning Andrew Ng Coursera - Neural Networks for Machine Learning by Geoffrey Hinton in Coursera

Course Code: UG COURSE: CAI3429	Course Title: Deep Learning Techniques for Computer Vision Type of Course: Integrated	L-T- P-C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	MAT2402					
Anti-requisites	NIL					
Course Description	This course covers the fundamentals and advanced concepts of deep learning for computer vision applications. Students will explore convolutional neural networks (CNNs), object detection, image segmentation, and generative models. Hands-on lab experiments will reinforce theoretical concepts using frameworks like TensorFlow and PyTorch.					
Course Out Comes	On successful completion of the course the students shall be able to: Understand the Fundamentals of Deep Learning for Vision Explain the core concepts of neural networks and deep learning architectures for image processing. Implement and optimize convolutional neural networks (CNNs) for classification tasks. Apply Object Detection and Image Segmentation Techniques Implement and analyze state-of-the-art object detection algorithms such as YOLO, Faster R-CNN, and SSD. Develop and evaluate image segmentation models like U-Net and Mask R-CNN. Explore Advanced Deep Learning Techniques for Vision Utilize Vision Transformers (ViTs) and attention mechanisms for image classification. Generate and manipulate images using Generative Adversarial Networks (GANs). Deploy and Optimize Deep Learning Models for Real-World Applications					

Course Content:				
Module 1	Fundamentals of Deep Learning for Vision	Assignment	Practical	No. of Classes:8
Introduction to Deep Learning & Neural Networks, Convolutional Neural Networks (CNNs) Architecture Backpropagation & Optimization in CNNs, Transfer Learning & Pretrained Models.				
Module 2	Object Detection & Image Segmentation	Assignment	Practical	No. of Classes:14
Introduction to Object Detection (R-CNN, SSD, YOLO), Region Proposal Networks (Faster R-CNN) Semantic & Instance Segmentation (U-Net, Mask R-CNN), Real-time Object Detection Applications				
Module 3	Advanced Topics in Vision	Assignment	Practical	No. of Classes:8
Attention Mechanisms & Vision Transformers (ViTs), Generative Adversarial Networks (GANs) for Image Generation, Self-supervised Learning for Vision, Multi-modal Learning (CLIP, DALL·E)				
Module 4	Applications & Deployment	Assignment	Practical	No. of Classes:8
Edge AI & Mobile Deployment (TensorFlow Lite, ONNX), Adversarial Attacks & Robustness in Vision Models, Explainability & Interpretability of Vision Models, Case Studies & Industry Applications				

Lab Experiments are to be conducted on the following topics:-

Lab Sheet 1:

Keras Sequential API model

Read in the data and explore

Define a Sequential API model

Define the hyperparameters and optimizer

Train the model and visualize the history

Testing

Keras Functional API model:

Define a Functional API model

Train the model and visualize the history

Lab Sheet 2:

Softmax regression with Keras

Read in the data and prepare

Define a Sequential API model

Define the hyperparameters and optimizer

Train the model and visualize the history

Testing

Lab Sheet 3:

Convolutional Neural Network with Keras (grayscale images)

Read in the data:

Visualize the data:

Prepare the data:

Define a CNN model:

Define the hyperparameters and optimizer:

Train the model and visualize the history:

Testing:

Lab Sheet 4:

Convolutional Neural Network with Keras (color images):

Read in the data:

Visualize the data:

Prepare the data:

Define a CNN model:

Define the hyperparameters and optimizer:

Train the model and visualize the history:

Testing:

Lab Sheet 5:

Time series and prediction:

Read in the data and explore:

Apply the exponential smoothing method and predict

Recurrent neural network (RNN):

Pre-processing:

Do the necessary definitions: (Hyper parameters, Model,

Train the model:

Predict the future:

Lab Sheet 6:

Document classification with LSTM network:

Read in the data:

Explore the data:

Data preprocessing:

Define the model:

Define the optimizer and compile:

Train the model and visualize the history:

Testing:

Lab Sheet 7:

Document classification with LSTM network (Binary):

Read in the data:

Explore the data:

Data preprocessing:

Define the model:

Define the optimizer and compile:

Train the model and visualize the history:

Testing:

Lab Sheet 8:

Document classification with LSTM + CNN network (Binary):

Read in the data:

Explore the data:

Data preprocessing:

Define the model:

Define the optimizer and compile:

Train the model and visualize the history:

Testing:

Lab Sheet 9:

Softmax regression to recognize the handswritten digits:

Download the MNIST data:

Take a look at the dataset:

Do the necessary definitions:

Training and Testing:

Multi-layer neural network to recognize the handswritten digits:

Download the MNIST data:

Take a look at the dataset:

Do the necessary definitions:

Training and Testing:

Lab Sheet 10:

Object Detection using YOLOv5

Lab Sheet 11:

Image Segmentation using U-Net

Custom Object Detection using Faster R-CNN

Lab Sheet 12:

Implementing Vision Transformers for Image Classification

Generating Images using GANs (DCGAN, StyleGAN)

(Group Project)

Object Detection and Recognition:

Haar cascade object detection (e.g., face detection or object detection using pre-trained classifiers).

Feature-based object detection using techniques like Speeded-Up Robust Features (SURF) or Scale-Invariant Feature Transform (SIFT).

Deep learning-based object detection using Convolutional Neural Networks (CNNs) or You Only Look Once (YOLO) algorithm.

Optical Character Recognition (OCR):

Preprocessing of text images (e.g., binarization, noise removal, or skew correction).

Text localization using techniques like connected component analysis or Stroke Width Transform (SWT).

Character recognition using machine learning algorithms like Support Vector Machines (SVM) or Convolutional Neural Networks (CNNs).

Gesture Recognition:

Hand segmentation using techniques like background subtraction or skin color detection.

Feature extraction from hand regions (e.g., finger counting, hand shape descriptors).

Classification of gestures using machine learning algorithms (e.g., k-Nearest Neighbors or Support Vector Machines).

Tools/Software Required :

OpenCV 4

Python 3.7

MATLAB

Text Books

"Deep Learning for Computer Vision Image Classification, Object Detection and Face Recognition in Python" Jason Brownlee (2019)

"Deep Learning for Computer Vision with python" Adrian Rosebrock (2017)

References

Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning. MIT Press.

A foundational book covering deep learning principles, including CNNs, optimization, and generative models.

Raschka, S., & Mirjalili, V. (2022). Machine Learning with PyTorch and Scikit-Learn. Packt Publishing.

Covers practical deep learning techniques using PyTorch, including CNNs and transfer learning.

Geron, A. (2022). Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow (3rd Edition). O'Reilly Media.

Provides hands-on implementations of deep learning for computer vision using TensorFlow and Keras.

Zhang, A., Lipton, Z. C., Li, M., & Smola, A. J. (2021). Dive into Deep Learning. Available online (https://d2l.ai).

Open-access book covering CNNs, object detection, and advanced vision techniques with PyTorch and TensorFlow.

Chollet, F. (2021). Deep Learning with Python (2nd Edition). Manning Publications.

Explains deep learning fundamentals and applications with Keras, including image classification and segmentation.

Ballé, J., Laparra, V., & Simoncelli, E. P. (2017). Deep Learning for Computer Vision: A Brief Introduction.

A concise introduction to CNNs, object detection, and generative models.

Course Code: CSE3426	Course Title: Front-end Full Stack Development Course Type : Lab Integrated		L- T-P- C	2	0	2	3
Version No.		1.0					
Course Pre-requisites		CSE2258					
Anti-requisites		NIL					
Course Description		This intermediate course enables students to perform front-end full stack development, with emphasis on employability skills. The course covers key technologies and architectures that enables the student to design and implement front-end. On successful completion of this course, the student shall be able to pursue a career in full-stack development. The students shall develop strong problem-solving skills as part of this course.					
Course Objectives		The objective of the course is to familiarize the learners with the concepts Front end Full Stack Development and attain Employability through experiential Learning techniques.					

Course Outcomes		On successful completion of the course the students shall be able to: 1] Describe the fundamentals of DevOps and Front-end full stack development. [Comprehension] 2] Illustrate a basic web design using HTML, CSS, Javascript. [Application] 3] Illustrate development of a responsive web. [Application] 4] Apply concepts of Angular.js to develop a web front-end. [Application]			
Course Content:					
Module 1	Fundamentals of DevOps	Project		Programming	04 Sessions
	Topics: Introduction to Agile Methodology; Scrum Fundamentals; Scrum Roles, Artifacts and Rituals; DevOps – Architecture, Lifecycle, Workflow & Principles; DevOps Tools Overview – Jenkins, Docker, Kubernetes. Review of GIT source control.				
Module 2	Web Design & Development	Project		Programming	03 Sessions
	Topics: HTML5 – Syntax, Attributes, Events, Web Forms 2.0, Web Storage, Canvas, Web Sockets; CSS3 – Colors, Gradients, Text, Transform; Assignment: Develop a website for managing HR policies of a department.				
Module 3	Responsive web design	Project		Programming	08 Sessions
	Topics: BootStrap for Responsive Web Design; JavaScript – Core syntax, HTML DOM, objects, classes, Async; Ajax and jQuery Introduction Assignment: Design and develop a website that can actively keep track of entry-exit information of a housing society.				
Module 4	Fundamentals of Angular.js	Project		Programming	15 Sessions
	Topics: Setting up Development & Build Environment: Node.js and NPM; Introduction to TypeScript; Working with OOP concepts with TypeScript; Angular Fundamentals; Angular CLI; Introduction to TypeScript; Debugging Angular applications; Components & Databinding in Depth; Angular Directives; Using Services & Dependency Injection; Angular Routing; Observables; Handling Forms in Angular Apps; Output transformation using Pipes; Making Http Requests; Authentication & Route Protection; Dynamic Components; Angular Modules & Optimizing Angular Apps; Deploying an Angular App; Angular Animations; Adding Offline Capabilities with Service Workers; Unit Testing in Angular Apps (Jasmine, Karma). Overview of React.js Assignment: Develop a software tool to do inventory management in a warehouse.				
	Targeted Application & Tools that can be used:				

	Application Area is to Design and Analyzing the efficiency of Algorithms. This fundamental course is used by all application developers. Professionally Used Software: GCC compiler.
	Text Book: T1. Fender, Young, "Front-end Fundamentals", Leanpub, 2015 T2. Northwood, Chris, "The Full Stack Developer: Your Essential Guide to the Everyday Skills Expected of a Modern Full Stack Web Developer", APress, 2018
	References: R1. Flanagan D S, "Javascript : The Definitive Guide" 7th Edition. 7th ed. O'Reilly Media; 2020. R2. Alex Libby, Gaurav Gupta, and Asoj Talesra. "Responsive Web Design with HTML5 and CSS3 Essentials", Packt Publishing, 2016 R3. Duckett J Ruppert G Moore J. "Javascript & Jquery : Interactive Front-End Web Development."; Wiley; 2014. R4. Web Reference: https://www.youtube.com/watch?v=JGNTYXkVCVY&list=PLd3UqWTnYXOkTSBCBNyyhxo_jxlY_uTWA&index=2 R5. Web Reference: https://www.freecodecamp.org/news/frontend-web-developer-bootcamp/ https://puniversity.informaticsglobal.com:2229/login.aspx?direct=true&db=nlebk&AN=2233842&site=ehost-live https://nptel.ac.in/courses/106102064
	Topics relevant to development of "Employability": DevOps Tools Overview – Jenkins, Docker, Kubernetes for developing Employability Skills through Experiential Learning techniques. This is attained through assessment component mentioned in course handout.

Course Code: CSE3427	Course Title: Java Full Stack Development Course Type: Lab Integrated		L- T-P- C	2	0	2	3
Version No.		1.0					
Course Pre-requisites		CSE2258					
Anti-requisites							

Course Description		This advanced level course enables students to perform full stack development using Java, with emphasis on employability skills. The key technologies used for Full Stack development is based on either Java technology or .NET technology. In this course, the focus is on using Java, and the related technologies/tools like Java EE, Java Persistence, Hibernate, Maven, Spring Core, etc. On successful completion of this course, the student shall be able to pursue a career in full-stack development. The students shall develop strong problem-solving skills as part of this course.			
Course Objectives		This course is designed to improve the learners' EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies.			
Course Outcomes		On successful completion of the course the students shall be able to: 1] Practice the use of Java for full stack development [Application] 2] Show web applications using Java EE. [Application] 3] Solve simple applications using Java Persistence and Hibernate [Application] 4] Apply concepts of Spring to develop a Full Stack application. [Application] 5] Employ automation tools like Maven, Selenium for Full Stack development. [Application]			
Course Content:					
Module 1	Introduction	Project		Programming	03 Sessions
	Topics: Review of Java; Advanced concepts of Java; Java generics; Java IO; New Features of Java. Unit Testing tools.				
Module 2	Java EE Web Applications	Project		Programming	05 Sessions
	Topics: Introduction to Eclipse & Tomcat; JSP Fundamentals; Reading HTML form Data with JSP; State Management with JSP; JSP Standard Tag Library - Core & Function Tags; Servlet API Fundamentals; ServletContext, Session, Cookies; Request Redirection Techniques; Building MVC App with Servlets & JSP; Complete App - Integrating JDBC with MVC App Assignment: Develop an application for managing HR policies of a department.				
Module 3	Java Persistence using JPA and Hibernate	Project		Programming	06 Sessions
	Topics: Fundamentals of Java Persistence with Hibernate; JPA for Object/Relational Mapping, Querying, Caching, Performance and Concurrency; First & Second Level Caching, Batch Fetching, Optimistic Locking & Versioning; Entity Relationships, Inheritance Mapping & Polymorphic Queries; Querying database using JPQL and Criteria API (JPA)				

	Assignment: Design and develop a website that can actively keep track of entry-exit information of a housing society.					
Module 4	Spring Core	Project		Programming		10 Sessions
	Topics: Spring Core, Spring MVC, Spring Boot REST API; Understanding Spring Framework; Using Spring MVC; Building a Database Web App with Spring and Hibernate o Spring AOP (Aspect Oriented Programming); Implementing Spring Security; Developing Spring REST API; Using Spring Boot for Rapid Development Assignment: Develop a software tool to do inventory management in a warehouse.					
Module 5	Automation tools	Project		Programming		06 Sessions
	Topics: Introduction to Automation Tools; Apache Maven: Maven Fundamentals, Software Setup - Commandline and Eclipse, pom.xml and Directory Structure, Multi-Module Project Creation, Scopes, Dependency Management, Profiles; Functional/BDD Testing using Selenium, Selenium Fundamentals and IDE, Selenium WebDriver, Installation and Configuration, Locating WebElements, Driver Commands, WebElement Commands Assignment: Illustrate the use of automation tools in the development of a small software project.					
	Targeted Application & Tools that can be used: Application Area is to Design and Analyzing the efficiency of Algorithms. This fundamental course is used by all application developers. Professionally Used Software: Eclipse, NetBeans, Hibernate, Selenium, Maven, GIT.					
	Project work/Assignment:					
	Problem Solving: Design of Algorithms and implementation of programs. Programming: Implementation of given scenario using Java.					
	Text Book: T1. Fender, Young, “Front-end Fundamentals”, Leanpub, 2015					
	References R1. Soni, Ravi Kant. “Full Stack AngularJS for Java Developers: Build a Full-Featured Web Application from Scratch Using AngularJS with Spring RESTful.”, Apress, 2017. R2. Mardan, Azat. “Full Stack JavaScript: Learn Backbone.js, Node.js and MongoDB.”, Apress, 2015					

Course Code: CSE3428	Course Title: .NET Full Stack Development Course Type: Lab Integrated	L- T-P-C	2	0	2	3

Version No.		1.0
Course Pre-requisites		CSE2258
Anti-requisites		
Course Description		This advanced level course enables students to perform full stack development using .NET, with emphasis on employability skills. The key technologies used for Full Stack development is based on either Java technology or .NET technology. In this course, the focus is on using .NET and the related technologies/tools like C#, ASP.NET, Entity Framework Core, etc. On successful completion of this course, the student shall be able to pursue a career in full-stack development. The students shall develop strong problem-solving skills as part of this course.
Course Objectives		This course is designed to improve the learners' EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies.
Course Outcomes		On successful completion of the course the students shall be able to: 1] Practice the use of C# for developing a small application [Application] 2] Show web applications using Entity Framework. [Application] 3]Solve simple web applications that use SQL and ASP.NET [Application] 4] Apply concepts of ASP.NET to develop a Full Stack application. [Application]
Course Content:		

Module 1	C# Programming for Full Stack Development	Project		Programming	10 Sessions
	Topics: .NET Framework Fundamentals, Visual Studio IDE Fundamentals, C# Language Features, Working with arrays and collections, Working with variables, operators, and expressions, Decision and iteration statements, Managing program flow and events, Working with classes and methods, OOP concepts, Properties, Auto Implemented, Delegates, Anonymous Methods and Anonymous Types, Extension methods, Sealed Classes/Methods, Partial Classes/Methods, Asynchronous programming and threading, Data validation and working with data collections including LINQ, Handling errors and exceptions, Working with Files, Unit Testing – Nunit framework Assignment: Develop a small application for managing library using C#.				
Module 2	Entity Framework Core 2.0	Project		Programming	06 Sessions

	Topics: Entity Framework Core 2.0 Code First Approach; Introduction To Entity Framework and EDM; Querying the EDM; Working With Stored Procedures; Advanced Entity Framework - DbContext [EF6]; Advanced Operations; Performance Optimization; Data Access with ADO.NET Assignment: Develop an application for managing HR policies of a department.				
Module 3	ASP.NET	Project		Programming	06 Sessions
	Topics: ASP.NET Core, ASP.Net Core 3.1 MVC, ASP.NET Core Middleware and Request pipeline, Review of SQL using MS SQL, Working With Data In Asp.Net, Razor View Engine, State Management In Asp. Net MVC & Layouts; Assignment: Develop a web application to mark entry/exit of guests in a building.				
Module 4	ASP.NET	Project		Programming	08 Sessions
	Topics: Introduction To Models, Validations In Asp.Net MVC, Authentication and Authorization In Asp.Net MVC, Advanced Asp. Net MVC - Ajax Action Link In MVC, Advanced Asp.Net MVC - Ajax Forms In MVC, Microsoft Testing Framework – Unit Testing the .NET Application Assignment: Develop a software tool to do inventory management in a warehouse.				
	Targeted Application & Tools that can be used: Application Area is to Design and Analyzing the efficiency of Algorithms. This fundamental course is used by all application developers. Professionally Used Software: Visual Studio				
	Project work/Assignment:				
	Problem Solving: Design of Algorithms and implementation of programs. Programming: Implementation of given scenario using .NET.				
	Text Book: T1. Fender, Young, “Front-end Fundamentals”, Leanpub, 2015 T2. Valerio De Sanctis, “ASP.NET Core 5 and Angular: Full-stack web development with .NET 5 and Angular 11”, 4th Edition, Packt, 2021.				
	References R1. Benjamin Perkins, Jon D. Reid, “Beginning C# and .NET”, Wiley, 2021 Reid, 2021. R2. Piotr Gankiewicz, “Full Stack .NET Web Development”, Packt Publishing, 2017. R3. Tamir Dresher, Amir Zuker, Shay Friedman, “Hands-On Full-Stack Web Development with ASP.NET Core”, Packt Publishing, 2018.				

	R4. Dustin Metzgar, "Exploring .NET core with microservices, ASP.NET core, and Entity Framework Core", Manning, 2017.

<table>
<tr><td>Course Code: RAI3400</td><td colspan="3">Course Title: Advanced Automation Design and Development
Type of Course: 1] Discipline Elective
2] Laboratory integrated</td><td>L- T - P- C</td><td>2</td><td>0</td><td>2</td><td>3</td></tr>
<tr><td>Version No.</td><td></td><td colspan="7">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td></td><td colspan="7">-</td></tr>
<tr><td>Anti-requisites</td><td></td><td colspan="7">NIL</td></tr>
<tr><td>Course Description</td><td></td><td colspan="7">The Advanced Automation Design and Development curriculum aims at providing a deep understanding and extensive hands-on experience. Helps in expanding your knowledge in key areas like advanced UI automation and data manipulation, Orchestrator triggers, AI Computer Vision, and remote debugging.</td></tr>
<tr><td>Course Objective</td><td></td><td colspan="7">The objective of the course is to familiarize the learners with the concepts of course Advanced Automation Design and Development to attain SKILL DEVELOPMENT through EXPERIENTIAL LEARNING TECHNIQUES.</td></tr>
<tr><td>Course Outcomes</td><td></td><td colspan="7">On successful completion of the course the students shall be able to:
CO 1: Explain and use key aspects to building enterprise level automations, using frameworks, and specifically the Robotic Enterprise Framework [Remember].
CO 2: Demonstrate the automation Methodologies for Control Flow and data manipulation techniques [Apply].
CO 3: Apply appropriate RPA Tools for the automation Process [Apply].
CO 4: Independently develop and implement complex automation solutions [Apply].</td></tr>
<tr><td></td><td colspan="8">Course Content:</td></tr>
<tr><td>Module 1</td><td>Automation development</td><td>Participative Learning</td><td colspan="2"></td><td></td><td colspan="3">No. of Classes
L-5 P-5</td></tr>
<tr><td></td><td colspan="8">Automation implementation methodology - Benefits. Debugging – Breakpoints Usage - Panels (watch, immediate, call stack) - Profile Execution - Types of UiPath Logs - Object Repository and its benefit - Library (Create, Publish, Import, and Update) - Workflow Analyzer - Test Suite Components and Their Integrations.</td></tr>
<tr><td>Module 2</td><td>State Machine, Introduction to Robotic Enterprise Framework</td><td>Participative Learning</td><td colspan="2"></td><td></td><td colspan="3">No. of Classes
L-5 P-5</td></tr>
<tr><td></td><td colspan="8">Difference between Sequence, Flowchart and State Machines - different states of State Machine - transitions in State Machine - apply State Machines in real scenarios - Create projects - blocks</td></tr>
</table>

	of a State Machine - types of processes - dispatcher/performer - RE Framework template - key mechanisms in RE Framework template - Configure workflows				
Module 3	Orchestrator Triggers and Monitoring	Experiential Learning			No. of Classes L-6 P-6
	Triggers, SLAs, job priorities and alerts - SLAs to automate job execution - Utilizing best practices to work on Orchestrator - remote debugging connection - types of connections - Invoke Method activity				
Module 4	Automation Advance Concepts and Features	Experiential Learning			No. of Classes L-7 P-6
	Practical benefits of LINQ queries - Interpret LINQ lambda expressions - Implement LINQ techniques to manipulate and extract data - Apply principles of LINQ to manipulate - data manipulation operations using Date Time variables - Remote Runtime in developing automations - WebDriver protocol - Computer Vision - works and its benefits - Computer Vision activities and recorder				
	List Of Laboratory Tasks:				
	Automating End-to-End Invoice Processing. Email Automation with Dynamic Attachments and Data Extraction. Web Scraping and Data Aggregation from Multiple Websites. Automating Employee Onboarding Process Automated Data Entry from PDFs into ERP Systems Automating Report Generation and Distribution Automated Monitoring and Reporting of System Health Intelligent Document Processing with AI Models Automating the Reconciliation Process in Accounting Customer Service Automation with Chatbots Automating Social Media Monitoring and Content Posting Automated Data Migration Between Legacy and Modern Systems Automated Testing of Web Applications Supply Chain Automation for Order Processing Automating Compliance Checks and Auditing				
	Text Book(s)				
	Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath by Alok Mani Tripathi, Packt Publishing, Mumbai, 2018 Tom Taulli, "The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems", Apress publications, 2020. Alok Mani Tripathi, Learning Robotic Process Automation, Publisher: Packt Publishing Release Date: March 2018 ISBN: 9787788470940				

	Robotic Process Automation a Complete Guide - 2020 Edition Kindle Edition.
	References:
	Richard Murdoch, "Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become an RPA Consultant" (1st Edition), Independently published, 2018. ISBN 978-1983036835. A Gerardus Blokdyk, "Robotic Process Automation Rpa a Complete Guide ", 2020. Frank Casale, Rebecca Dilla, Heidi Jaynes and Lauren Livingston, "Introduction to Robotic Process Automation: A Primer. EMC education services. Information Storage and Management: Storing, Managing, and Protecting Digital Information in Classic, Virtualized, and Cloud Environments, Wiley, 2012. Web Resources and Research Articles links: IEEE Transactions on Robotic Process Automation- https://ieeexplore.ieee.org/abstract/document/9114349 NPTEL Course on " Robotics, IIT Bombay by Prof. B. Seth, Prof. C. Amarnath, Prof. K. Kurien Issac, Prof. P.S. Gandhi, Prof. P. Seshu https://nptel.ac.in/courses/112101098 https://academy.uipath.com/learning-plans/automation-developer-associate-training https://docs.uipath.com/studio/standalone/2022.10/user-guide/install-studio https://docs.uipath.com/ https://community.uipath.com/ https://forum.uipath.com/ https://www.uipath.com/learning/certification https://www.uipath.com/rpa/robotic-process-automation
	Topics relevant to "SKILL DEVELOPMENT" Creating a provision Robot from the Server, Connecting a Robot to Server, Deploy the Robot to Server for Skill Development through Participative Learning techniques. This is attained through the Assignment/ Class Presentation/Group Discussion/Flipped Class as mentioned in the assessment component.

Course Code RAI3401	Course Title: Business Analysis with Automation Solutions Type of Course: Discipline Elective - Lab Integrated	L- T-P-C	2	0	2	3

Version No.	1			
Course Pre-requisites	-			
Anti-requisites	NILL			
Course Description	Business analysis is a professional discipline for identifying business needs and determining solutions to business problems. Through this course, students can acquire business analysis skills across six key knowledge areas. These are Business Analysis Planning and Monitoring, Elicitation and Collaboration, Requirements Lifecycle Management, Strategy Analysis, Requirements Analysis and Design Definition, and Solution Evaluation. All this through Automation's perspective! This is an industry relevant course that will help students transition to the practical and authentic application of theory, techniques, and tools. It will also help to develop in-demand business analysis skills to support RPA/Automation solutions.			
Course Objective	The objective of the course is to familiarize the learners with the concepts of Business Analysis and attain Skill Development through Participative Learning techniques.			
Course Outcomes	On successful completion of this course, the students shall be able to: CO1: Demonstrate proficiency in identifying, documenting, and analyzing business requirements using the Business Analysis Core Concept Model (BACCM) framework. (Understand) CO2: Use and understand the various practices, competencies, techniques, and models for conducting business analysis.(Understand) CO3: Apply the essential skills and techniques required for a Business Analyst to define project strategy, scope, and requirements. (Apply) CO4: Apply various techniques to define solution requirements, create future state process maps, and document business rules and data requirements. (Apply)			
Course Content:				
Module 1	Introduction to Business Analysis	Assignment		L-5 P-5
The five W's of business analysis - Business Analysis Core Concept Model (BACCM) - Templates for documenting business analysis artifacts - Requirements - Requirements architecture - Requirements and design.				
Module 2	Analysis, Elicitation, and Stakeholder Engagement	Assignment		L-5 P-5
Business analysis and its purpose - Techniques for conducting stakeholder analysis - Requirements analysis framework - Various stages of elicitation processes - Elicitation techniques - Workshop - Key phases necessary for conducting a workshop - Plan to host elicitation events in a project context				
Module 3	Requirement Strategy and Scope Analysis	Assignment		L-6 P-6

The role of a Business Analyst in the strategy and scope definition phases - Key competencies of a Business Analyst in automation discovery journey - Key perspectives of discovery along with their techniques - Business requirements and documentation - Process analysis - Standards for process modeling - Common techniques used to define Requirements Scope - Process for qualifying automation ideas into a valid opportunity.				
Module 4	Requirement Specification	Assignment		L-7 P-6
The role of BA in Solution phase - The techniques to define solution requirements - The techniques to define the future state - Steps to create a future state process map -The elements of the Use Case Specification - The types of business rules – The document business rules, data requirements and the interactive elements of the use case - The data requirements taxonomy.				

Lab Experiments:

UiPath Lab 1: Identify and Analyze Requirements Using BACCM

Aligned with CO1 – Understand BACCM and business requirements

Objective:
Use a real-world business problem to identify BACCM elements and then create a UiPath project structure based on those insights.

Steps:

Choose a simple business scenario (e.g., invoice processing or leave management).

Identify and document:

Need, Change, Solution, Stakeholder, Value, Context

Create a UiPath project and name variables and folders reflecting the BACCM structure (e.g., "Stakeholder_Input").

Deliverable:
BACCM worksheet + initial UiPath project setup.

UiPath Lab 2: Applying BA Techniques in UiPath Context

Aligned with CO2 – Understand BA techniques and models

Objective:
Use business analysis tools to guide a UiPath automation solution.

Steps:

Select a manual business process (e.g., travel expense approval).

Apply 2–3 BA techniques:

SWOT for feasibility

MoSCoW for requirement prioritization

Use Case diagram for workflow planning

Based on the analysis, define the automation requirements.

Deliverable:
BA techniques report + UiPath automation plan (flowchart/mock-up).

UiPath Lab 3: Define Strategy, Scope, and Requirements in UiPath

Aligned with CO3 – Apply skills to define project strategy and scope

Objective:
Develop and implement a small automation project by defining clear scope and requirements.

Steps:

Choose a use case (e.g., email sorting, data scraping).

Define:

Business goal

Scope boundaries

Requirements (functional/non-functional)

Implement basic automation in UiPath (Sequence/Flowchart).

Deliverable:
Scope document + UiPath workflow + requirement list.

UiPath Lab 4: Define Solution Requirements and Future-State Process

Aligned with CO4 – Apply techniques for process mapping and solution documentation

Objective:
Create As-Is and To-Be process maps and automate the future state.

Steps:

Document an existing manual process (As-Is) using diagrams.

Redesign the optimized (To-Be) version.

Implement the To-Be process using UiPath (e.g., PDF reading + Excel entry).

Document:

Business rules

Data formats and validations

Deliverable:
As-Is/To-Be diagrams + UiPath solution + business rules document.

Targeted Application & Tools that can be used: UIPath

Project work/Assignment:

Project Assignment:

Assignment 1: Module 1 & 2

Assignment 2: Module 3 & 4

Textbooks:

Debra Paul, James Cadle, and Donald Yeates, Business Analysis, BCS Learning & Development Ltd, 2014.

(Requested UiPath for Textbook through an email)

References:

Howard Podeswa, The Business Analyst's Handbook, Course Technology PTR, 2019.

A guide to the Business Analysis body of knowledge, IIBA, International Institute of Business Analysis. 2015 Web references: https://academy.uipath.com/learning-plans/automation-business-analyst-foundation https://www.coursera.org/learn/automation-business-analyst https://academy.uipath.com/courses/automation-implementation-methodology-deep-dive-for-businessanalysts https://www.uipath.com/platform https://www.uipath.com/solutions https://forum.uipath.com/ https://www.uipath.com/learning/certification
Topics relevant to “SKILL DEVELOPMENT”: The concepts of Business Analysis Core Concept Model (BACCM) , Techniques for conducting stakeholder analysis, Elicitation techniques, Process Definition Document (PDD) using the Requirements Template for Skill Development through Participative Learning techniques. This is attained through assessment component mentioned in the course handout.

Course Code: RAI3402	Course Title: AI for IoT Applications Type of Course: Integrated	L- T-P- C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	CSE2264					
Anti-requisites	NIL					
Course Description	This course explores the integration of Artificial Intelligence (AI) with the Internet of Things (IoT) to build intelligent, adaptive, and data-driven systems. It covers the architecture of AI-enabled IoT systems, data acquisition and analytics, machine learning for sensor data, and real-world applications in smart homes, healthcare, industry, and agriculture. Students will gain hands-on experience in applying AI algorithms to solve IoT challenges.					
Course Objective	☐ To understand the fundamentals of AI and its significance in IoT systems. ☐ To analyze the role of machine learning and deep learning for IoT data processing. ☐ To explore frameworks, tools, and platforms for AI-enabled IoT application development. ☐ To apply AI techniques in solving real-world problems across various IoT domains.					
Course Outcomes	At the end of this course, students will be able to: CO1: Identify and explain the architecture and components of AI-integrated IoT systems.					

	CO2: Implement machine learning algorithms for sensor data analytics in IoT. CO3: Design and evaluate AI models for smart applications using real-time data. CO 4:Develop intelligent IoT applications using cloud, edge AI, and relevant toolkits.

Course Content:

Module 1	Introduction to AI and IoT Integration	Assignment 1	11

Topics:

Understand the foundational concepts of AI and IoT and their convergence. Learn about IoT architecture, protocols like MQTT and CoAP, and how AI enhances data interpretation in IoT. Explore the end-to-end AI-IoT pipeline and examine use cases from smart cities and homes.

Module 2	IoT Data Acquisition and Preprocessing	Assignment 1	11

Topics:

Explore the nature and structure of data from IoT sensors. Learn techniques for cleaning, filtering, and transforming time-series and real-time data. Understand feature extraction and labeling methods to make data AI-ready.

Module 3	Machine Learning Models for IoT	Assignment 2	11

Topics:

Study supervised and unsupervised learning methods such as decision trees, clustering, and regression for analyzing sensor data. Learn how to train, test, and validate models using IoT datasets. Understand model optimization and the basics of deploying ML on edge devices.

Module 4	Deep Learning and Edge Intelligence		12

Topics:

Dive into ANN, CNN, and RNN models suited for image, sound, and sequential data from IoT systems. Implement deep learning models for tasks like object detection and predictive maintenance. Explore frameworks like TensorFlow Lite and tools for deploying models on devices like Raspberry Pi.

Project work/Assignment:

Assignment 1 on (Module 1 and Module 2)

Assignment 2 on (Module 3)

REFERENCE MATERIALS:

Textbooks

Arshdeep Bahga and Vijay Madisetti, Internet of Things: A Hands-on Approach, Universities Press, 2015.

Reference Books

Adeel Javed, Building Arduino Projects for the Internet of Things, Apress, 2016.

Yasser Elkhatib, Edge Intelligence in the Internet of Things, Springer, 2022. Peter Waher, Learning Internet of Things, Packt Publishing, 2015. Mehdi Roopaei et al., Deep Learning for IoT Data Analytics, Springer, 2021. Rajiv Ranjan et al., Handbook of Edge Computing and IoT: Smart Cities and Industry 4.0, Springer, 2023.

Course Code: RAI3403	Course Title: AI for Robotics Type of Course: Lab Integrated		L- T- P- C	2	0	2	3
Version No.		1					
Course Pre-requisites		CSE1500					
Anti-requisites							
Course Description		The course "Artificial Intelligence for Robotic" aims to provide students with a deep understanding of the theoretical foundations and advanced concepts in artificial intelligence (AI) as they apply to robotics. The course delves into the theoretical underpinnings of AI algorithms, models, and methodologies used in robotic systems, enabling students to analyze and develop novel AI solutions for complex robotic tasks. Through a combination of lectures, discussions, and theoretical exercises, students will explore key AI theories and their applications in robotics. Students will also critically analyze research papers and gain insights into the current state-of-the-art in AI for robotics.					
Course Objective		The objective of the course is to familiarize the learners with the concepts of course Artificial Intelligence for Robotics and attain Skill Development through Participative Learning techniques.					

Course Out Comes		On successful completion of the course the students shall be able to: Identify the basics of artificial intelligence and its application in the context of robotics. [Remember] Describe the fundamental concepts and components of robotics, including robot anatomy and the systems engineering approach. [Understand] Apply knowledge of image recognition processes and techniques, including image processing, convolution, artificial neurons, and convolutional neural networks. [Apply] Apply knowledge about how to build a system which detect objects and speech using driftnet techniques. [Apply]
Course Content:		

Module 1	Foundation for Robotics and AI		L-5 P-5
	Topics: The basic principle of robotics and AI: Introduction to AI, the example problem – clean up this room, OODA (Observe- Orient-Decide- Act) loop, Artificial intelligence and advanced robotics Techniques, Introducing the robot and development environment, Software components (ROS, Python, and Linux), Robot control systems and a decision-making framework, The robot control system – a control loop with soft real-time control.		
Module 2	Robot Design Process		L-5 P-5
	Topics: Introduction to what is a robot, Robot anatomy – robots made of, A systems engineering-based approach to robotics, Subsumption architecture, Use cases (The Problem Part-1, Problem Part-2), Subsumption architecture: Storyboard – put away the toys, Decomposing hardware needs, Breaking down software needs.		
Module 3	Object Recognition Using Neural Networks		L-6 P-6
	Topics: The image recognition process, Technical requirements, The image recognition training and deployment process – step by step, Image processing, Convolution, Artificial neurons, The convolution neural network process, Build the toy/not toy detector		
Module 4	Robot speech recognition		L-7 P-6
	Topics: Introduction to Teaching a Robot to Listen, teaching a Robot to Listen, Robot speech recognition, Robot speech recognition, Intent, Mycroft, Demo of speech recognition.		
	Lab Experiment: Module 1: Foundation for Robotics and AI (L-5 P-5) Lab 1.1: Getting Started with ROS and Linux Objective: Set up ROS environment and explore basic Linux commands for robotics. Tools: ROS (Noetic/other), Ubuntu OS, Terminal Procedure: Install ROS and set up your workspace.		

	Practice common Linux commands (navigation, file manipulation). Launch a sample robot simulation in ROS (e.g., TurtleBot).
	Lab 1.2: Implementing the OODA Loop in Code Objective: Simulate the OODA decision cycle using Python. Tools: Python Procedure: Code each step of the OODA loop. Create a basic environment (e.g., cleaning room simulator). Simulate decisions based on sensor input and actuate a response.
	Module 2: Robot Design Process (L-5 P-5) Lab 2.1: Virtual Robot Anatomy Breakdown Objective: Identify and label robot components in simulation software. Tools: RViz, Gazebo, robot model (URDF file) Procedure: Load robot model in simulation. Identify sensors, actuators, and control systems. Annotate a report with each component’s function.
	Lab 2.2: Design Subsumption Architecture Objective: Implement a behavior-based controller using subsumption principles. Tools: Python, ROS Procedure: Design layered behaviors: obstacle avoidance, object following. Use ROS nodes to simulate each behavior. Demonstrate priority handling between behaviors.
	Module 3: Object Recognition Using Neural Networks (L-6 P-6) Lab 3.1: Preprocessing Images for Neural Networks Objective: Prepare image dataset for neural network training. Tools: Python, OpenCV Procedure: Load images and convert to grayscale. Apply resizing, normalization, and edge detection. Save processed images to dataset folder.

	Lab 3.2: Build and Train a CNN to Detect Toys Objective: Implement a CNN for object classification. Tools: TensorFlow or PyTorch Procedure: Build a simple CNN model (input-conv-pool-dense-output). Train on toy vs. non-toy dataset. Test accuracy and plot confusion matrix.
	Module 4: Robot Speech Recognition (L-7 P-6) Lab 4.1: Basic Speech-to-Text Conversion Objective: Convert voice input into text using open-source tools. Tools: Mycroft, Google Speech API, microphone Procedure: Record user input. Transcribe speech using a speech recognition library. Display the transcribed text in terminal.
	Lab 4.2: Implement a Voice-Controlled Command System Objective: Control a robot simulation using voice commands. Tools: Mycroft + ROS integration Procedure: Define intents and corresponding robot actions. Use voice commands to trigger actions (e.g., "move forward"). Test response time and accuracy.
	Targeted Application & Tools that can be used: Application Area: Resource Allocation, Finance and Economics (Risk Analysis and Consumption Assessment), Fraud Detection, Image Segmentation, Dimensionality Reduction, Gene Expression Analysis, Recommender System, Image reconstruction, Large Scale Surveillance. Tools: Anaconda Navigator Python Packages
	Project work/Assignment:
	Assignment: Train a system to recognize the speech.

	Train a system to recognize the object.
	Text Book T1. Artificial Intelligence for Robotics by Francis X. Govers, Released August 2018, Publisher(s): Packt Publishing, ISBN: 9781788835442.
	References R1. Introduction to AI Robotics Robin R. Murph, ISBN 0-262-13383-0 (hc.: alk. paper) R2. Introduction to AI Robotics, Second Edition by Robin R. Murphy, ISBN 9780262348157 E book link R1: https://doc.lagout.org/science/0_Computer%20Science/8_Electronics%20%26%20Robotics/Introduction%20to%20AI%20Robotics%20-%20Murphy%20R.R.pdf
	Topics relevant to development of "Skill Development": Object Detection, Speech Recognition

Course Code: RAI3404	Course Title: Robotic System Design Type of Course: Theory & Integrated Laboratory	L- T-P- C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	This course focuses on the principles and techniques used in designing robotic systems and implementing Simultaneous Localization and Mapping (SLAM) algorithms. Students will gain a deep understanding of how robots perceive, navigate, and map their environments, enabling autonomous operation in dynamic and unknown spaces. The course covers theoretical foundations, algorithm development, and practical implementations, emphasizing real-world applications in robotics, such as autonomous vehicles, drones, and service robots.					
Course Objective	This course is designed to improve the learners 'EMPLOYABILITY SKILLS' by using EXPERIENTIAL LEARNING techniques.					

Course Outcomes	After the completion of this course, the students will be able to: Understand the features and uses of Robotic Operating System (ROS) and allied software tools. Generate a robot manipulator and its working environment using simulation tools. Implement robot navigation and object manipulation for a given application. Incorporate and use robot vision for real-world applications			
Course Content:				
Module 1	Introduction	Assignment		L-5 P-5
Topics: Industrial Applications of Robots, Industrial Environments and Constraints, Free Open Source Software for Robot Simulation, Robotic Operating System (ROS), Gazebo, MoveIt, Ubuntu, Python, Installing and Configuring Simulation Software's.				
Module 2	Robotic Operating System	Assignment		L-5 P-5
Topics: Robotic Operating System (ROS) Fundamentals, Building a ROS Application, ROS Services, ROS Actions, Unified Robot Description Format (URDF).				
Module 3	Sensor and Robot Navigation	Assignment		L-6 P-6
Topics: Slam: Simultaneous Localization and Mapping (SLAM) implementation with ROS2 packages and C++. Combining mapping algorithms with the localization concepts, Introduction to the Mapping and SLAM concepts and algorithms. Occupancy Grid Mapping, Mapping an environment with the Occupancy Grid Mapping algorithm, Grid-based FastSLAM: Simultaneous mapping an environment and localize a robot relative to the map with the Grid-based FastSLAM algorithm, Self-Localisation, Path Planning and Obstacle Avoidance, Map-Building and Map Interpretation, Simultaneous Localization and Mapping, Navigation using Software Tools.				
Module 4	Manipulation and Robot Vision	Assignment		L-7 P-6
Topics: Object Manipulation, Manipulation Planning Algorithms, Prehension, Manipulation using Software Tools. Object Detection, Pose Estimation, Logical Camera, ROS Tools for Vision.				
Project work/Assignment:				
Assignment 1 on Module 1 and Module 2 Assignment 2 on Module 3 and Module 4				
Detailed Content: • To install ROS and set-up a ROS workspace on a computer. • To write ROS talker-listener code in python. • To create a mobile robot base URDF model. • To create a 3-DOF robot arm URDF model.				

● To simulate a mobile robot base in Gazebo.

● To attach the robot arm to base and simulate the complete mobile robot in Gazebo.

● To create an environment in Gazebo for simulating a mobile robot for an industrial application.

● To implement SLAM for industrial application using ROS open-source packages.

● To configure and interface a webcam with ROS.

● To use OpenCV with ROS for a vision application.

Suggested Text Books:

(i) Morgan Quigley, "Programming Robots with ROS: A Practical Introduction to the Robot Operating System", O'Reilly Media, 2015.

(ii) Carol Fairchild, Dr. Thomas L. Harman, "ROS Robotics by Example", Packt, 2016.

Suggested Reference Books:

(i) Anis Koubaa, "Robot Operating System", Springer link, 2016.

(ii) Anil Mahtani, "Effective Robotics Programming with ROS", Packt Publishing, 2016.

(iii) Ramkumar Gandhinathan , Lentin Joseph , " ROS Robotics Projects: Build and control robots powered by the Robot Operating System, machine learning, and virtual reality", Packt Publishing Limited, December 2019.

(iv) SLAM for dummies: https://dspace.mit.edu/bitstream/handle/1721.1/119149/16-412jspring-2005/contents/projects/1aslam_blas_repo.pdf

(v) ROS Robot Programming; YoonSeok Pyo I HanCheol Cho I RyuWoon Jung I TaeHoon Lim; https://community.robotsource.org/t/download-the-ros-robot-programming-bookfor-free/51

Detailed Content:

● To install ROS and set-up a ROS workspace on a computer.

● To write ROS talker-listener code in python.

● To create a mobile robot base URDF model.

● To create a 3-DOF robot arm URDF model.

● To simulate a mobile robot base in Gazebo.

● To attach the robot arm to base and simulate the complete mobile robot in Gazebo.

● To create an environment in Gazebo for simulating a mobile robot for an industrial application.

● To implement SLAM for industrial application using ROS open-source packages.

● To configure and interface a webcam with ROS.

● To use OpenCV with ROS for a vision application.

Suggested Text Books:

(i) Morgan Quigley, "Programming Robots with ROS: A Practical Introduction to the Robot Operating System", O'Reilly Media, 2015.

(ii) Carol Fairchild, Dr. Thomas L. Harman, "ROS Robotics by Example", Packt, 2016.

Suggested Reference Books:

(i) Anis Koubaa, "Robot Operating System", Springer link, 2016.

(ii) Anil Mahtani, "Effective Robotics Programming with ROS", Packt Publishing, 2016.

(iii) Ramkumar Gandhinathan , Lentin Joseph , " ROS Robotics Projects: Build and control robots powered by the Robot Operating System, machine learning, and virtual reality", Packt Publishing Limited, December 2019.

(iv) SLAM for dummies: https://dspace.mit.edu/bitstream/handle/1721.1/119149/16-412jspring-2005/contents/projects/1aslam_blas_repo.pdf

(v) ROS Robot Programming; YoonSeok Pyo I HanCheol Cho I RyuWoon Jung I TaeHoon Lim; https://community.robotsource.org/t/download-the-ros-robot-programming-bookfor-free/51

Suggested Text Books:
(i) Sabrie Soloman, Advanced Robotics (Design & Applications), Khanna Book Publishing, 2023.
(ii) Morgan Quigley, "Programming Robots with ROS: A Practical Introduction to the Robot
Operating System", O'Reilly Media, 2015.
(iii) Carol Fairchild, Dr. Thomas L. Harman, "ROS Robotics by Example", Packt, 2016.

Suggested Reference Books:
(i) Anis Koubaa, "Robot Operating System", Springer link, 2016.
(ii) Anil Mahtani, "Effective Robotics Programming with ROS", Packt Publishing, 2016.
(iii) Ramkumar Gandhinathan , Lentin Joseph , " ROS Robotics Projects: Build and control
robots powered by the Robot Operating System, machine learning, and virtual reality",
Packt Publishing Limited, December 2019.
(iv) Santosh Mukherjee, Essentials of Robotics Process Automaion, Khanna Publishing
House, 2023.
(v) SLAM for dummies: https://dspace.mit.edu/bitstream/handle/1721.1/119149/16-412jspring-2005/contents/projects/1aslam_blas_repo.pdf
(vi) ROS Robot Programming; YoonSeok Pyo I HanCheol Cho I RyuWoon Jung I TaeHoon
Lim; https://community.robotsource.org/t/download-the-ros-robot-programming-bookfor-free/51

<table>
<tr><td>Course Code:
RAI3406</td><td colspan="3">Course Title: Robot Perception and Control
Type of Course: Theory & Integrated Laboratory</td><td>L- T-P- C</td><td>2</td><td>0</td><td>2</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="8">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="8">NIL</td></tr>
<tr><td>Anti-requisites</td><td colspan="8">NIL</td></tr>
<tr><td>Course Description</td><td colspan="8">This course provides an in-depth understanding of robot perception and control systems. It focuses on the integration of sensor data for environmental perception and feedback control strategies for robot movement. The course combines theory with hands-on lab experiments using simulation and hardware platforms to build skills in robotic sensing, estimation, and control.</td></tr>
<tr><td>Course Objective</td><td colspan="8">To equip students with the knowledge and skills required for sensing, perceiving, and controlling robotic systems using modern tools and algorithms.</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">Understand the fundamentals of perception and control in robotics. (Understand)
Process sensor data to extract meaningful information for robot decision-making. (Apply)
Analyze various feedback control strategies in mobile and manipulator robots. (Analyze)
Design perception-driven control systems in simulated and real-world environments. (Create)</td></tr>
<tr><td colspan="9">Course Content:</td></tr>
<tr><td>Module 1</td><td>Introduction to Robot Perception</td><td>Understand</td><td colspan="4"></td><td colspan="2">L-5 P-5</td></tr>
<tr><td colspan="9">Overview of robot perception, types of sensors (visual, LiDAR, IMU, ultrasonic), sensor noise, sensor fusion, signal preprocessing.</td></tr>
<tr><td>Module 2</td><td>Visual Perception and Feature Extraction</td><td>Apply</td><td colspan="4"></td><td colspan="2">L-5 P-5</td></tr>
<tr><td colspan="9">Image formation, edge detection, corner detection, optical flow, depth estimation, visual odometry</td></tr>
</table>

Module 3	Robot Control Fundamentals	Analyze		L-6 P-6
Open-loop vs. closed-loop systems, PID control, trajectory tracking, inverse kinematics, control of mobile robots and manipulators.				
Module 4	Integrated Perception and Control	Create		L-7 P-6
Perception-based control, visual servoing, SLAM with control loops, autonomous decision making, real-world applications.				
Project work/Assignment:				
Assignment 1 on Module 1 and Module 2 Assignment 2 on Module 3 and Module 4				
List of Laboratory Tasks: Lab 1: Introduction to Perception Tools (OpenCV/ROS sensors) Objective: Use camera and range sensors for basic environmental capture. Lab 2: Visual Feature Extraction Objective: Detect edges, corners, and contours using real-world images. Lab 3: Sensor Fusion for Localization Objective: Combine IMU and GPS data for reliable robot localization. Lab 4: Implement PID Controller for Line Following Robot Objective: Program a line follower using feedback control. Lab 5: Visual Servoing for Object Tracking Objective: Use camera input to track and move toward an object. Lab 6: SLAM with LiDAR and Odometry Objective: Use ROS or Gazebo to build a map using SLAM techniques. Lab 7: Inverse Kinematics for Robotic Arm Objective: Calculate and simulate desired joint angles to reach targets. Lab 8: Full Perception-Control Integration				

Objective: Design a robot that can perceive an object and navigate to it autonomously.
TEXTBOOKS; 1. Paul Newman and Mike Milford, "Introduction to Robot Perception", MIT OpenCourseware Notes. Bruno Siciliano and Lorenzo Sciavicco, "Modelling and Control of Robot Manipulators", Springer, 2010. REFERENCE MATERIALS: Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2022. Roland Siegwart, Illah Nourbakhsh, Davide Scaramuzza, "Introduction to Autonomous Mobile Robots", MIT Press, 2011. Peter Corke, "Robotics, Vision and Control: Fundamental Algorithms", Springer, 2017. REFERENCES JOURNALS/MAGAZINES SWAYAM/NPTEL/MOOCs:

Course Code: RAI3407	Course Title: Autonomous Systems and Path Planning Type of Course: Theory & Integrated Laboratory	L- T-P- C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	This course introduces students to the design and analysis of autonomous systems with an emphasis on path planning, localization, and navigation strategies. Students will explore algorithms and frameworks used in robotics and autonomous vehicles, covering concepts like SLAM, obstacle avoidance, and motion planning.					
Course Objective	To impart foundational and practical knowledge of autonomous navigation systems, enabling students to design, simulate, and implement real-time path planning and decision-making algorithms.					
Course Outcomes	Explain the core components and design principles of autonomous systems. (Understand) Apply path planning algorithms like Dijkstra, A*, and RRT for navigation tasks. (Apply)					

	Analyze real-time motion planning, SLAM, and localization frameworks. (Analyze) Design intelligent autonomous systems using sensor data and AI techniques. (Create)

Course Content:

Module 1	Introduction to Autonomous Systems	Understand		L-5 P-5

Architecture of autonomous systems, sensors and actuators, perception, control, and decision making.

Module 2	Path Planning Algorithms	Analyze		L-5 P-5

Graph-based methods, Dijkstra's algorithm, A*, RRT, dynamic path planning, collision avoidance.

Module 3	Localization and SLAM	Apply		L-6 P-6

Probabilistic localization, Kalman filter, Particle filter, Simultaneous Localization and Mapping (SLAM).

Module 4	Applications and Future Trends			L-7 P-6

Autonomous vehicles, drones, mobile robots, integration with AI, ethical considerations, emerging technologies.

Project work/Assignment:

Assignment 1 on Module 1 and Module 2

Assignment 2 on Module 3 and Module 4

List of Laboratory Tasks:

Lab 1: Introduction to Robotics Simulators (Webots/ROS/Gazebo)
Objective: Understand simulation tools for autonomous navigation.

Lab 2: Sensor Integration and Data Acquisition
Objective: Connect and interpret data from LIDAR, GPS, and ultrasonic sensors.

Lab 3: Implement Dijkstra and A* Algorithms
Objective: Create pathfinding routines using graph traversal algorithms.

Lab 4: Obstacle Avoidance using Reactive Methods
Objective: Program real-time obstacle detection and avoidance strategies.

Lab 5: Implement Particle Filter for Localization
Objective: Simulate robot localization in a known map.

Lab 6: SLAM using ROS Packages
Objective: Perform mapping and localization simultaneously in unknown environments.

Lab 7: Path Tracking with Feedback Control Objective: Design control systems to follow predefined trajectories. Lab 8: Autonomous Navigation Challenge Objective: Integrate all systems in a simulated or real-world task.
TEXTBOOKS; 1. Roland Siegwart, Illah Nourbakhsh, and Davide Scaramuzza, "Introduction to Autonomous Mobile Robots", MIT Press, 2011. 2. Steven M. LaValle, "Planning Algorithms", Cambridge University Press, 2006. REFERENCE MATERIALS: 1. Howie Choset et al., "Principles of Robot Motion: Theory, Algorithms, and Implementations", MIT Press, 2005. 2. Sebastian Thrun, Wolfram Burgard, Dieter Fox, "Probabilistic Robotics", MIT Press, 2005. REFERENCES JOURNALS/MAGAZINES SWAYAM/NPTEL/MOOCs:

Course Code: RAI3408	Course Title: Swarm Intelligence Type of Course: Theory	L- T-P- C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	This course explores the principles and applications of Swarm Intelligence, inspired by the collective behavior of social organisms such as ants, bees, birds, and fish. It provides insight into decentralized systems, self-organization, and how local interactions lead to the emergence of intelligent global behavior in artificial systems.					
Course Objective	To understand the foundational theories and real-world applications of Swarm Intelligence techniques, and apply them to problem-solving using bio-inspired algorithms and simulations.					

Course Outcomes	Explain the fundamentals of swarm-based systems and natural behaviors. (Understand) Analyze swarm algorithms such as Ant Colony Optimization and Particle Swarm Optimization. (Analyze) Implement and evaluate swarm intelligence techniques for optimization problems. (Apply) Design decentralized systems using bio-inspired strategies. (Create)			
Course Content:				
Module 1	Introduction to Swarm Intelligence	Understand		L-5 P-5
Natural swarm behaviors, collective intelligence, decentralized systems, bio-inspiration in computing				
Module 2	Ant Colony Optimization	Analyze		L-5 P-5
Foraging behavior in ants, pheromone trails, ACO algorithms for routing and scheduling, variations and improvements.				
Module 3	Particle Swarm Optimization	Apply		L-6 P-6
Flocking behavior, velocity and position updates, PSO variants, applications in continuous optimization.				
Module 4	Applications and Hybrid Approaches			L-7 P-6
Swarm robotics, hybrid algorithms (GA+ACO, PSO+NN), real-world case studies, emerging trends in swarm intelligence.				

TEXTBOOKS;

1. Marco Dorigo and Thomas Stützle, "Ant Colony Optimization", MIT Press, 2004.
2. James Kennedy and Russell Eberhart, "Swarm Intelligence", Morgan Kaufmann, 2001

REFERENCE MATERIALS:

1. Eric Bonabeau, Marco Dorigo, Guy Theraulaz, "Swarm Intelligence: From Natural to Artificial Systems", Oxford University Press, 1999.
2. Ying Tan, "Swarm Intelligence Algorithms: A Tutorial", CRC Press, 2018.

REFERENCES

JOURNALS/MAGAZINES

SWAYAM/NPTEL/MOOCs:

Course Code: RAI3409	Course Title: Humanoid Robots Type of Course: Theory		L- T-P- C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	This course introduces the fundamental concepts, design principles, and technologies used in the development of humanoid robots. It provides practical and theoretical knowledge of humanoid structure, locomotion, perception, and interaction. The course aims to develop an understanding of kinematics, dynamics, control systems, and AI integration in humanoid robots.					
Course Objective	This course is designed to improve learners' employability skills by using experiential learning techniques to understand, design, and implement humanoid robotic systems.					
Course Outcomes	Explain the key components and functions of humanoid robotic systems. (Understand) Analyze the kinematic and dynamic models of humanoid robots. (Analyze) Design basic control algorithms for humanoid motion and interaction. (Apply) Integrate perception systems and AI techniques in humanoid robot platforms. (Apply)					
Course Content:						
Module 1	Introduction to Humanoid Robots	Understand		L-5 P-5		
History and evolution of humanoid robots, applications, anatomy of humanoids, design challenges, degrees of freedom, sensors and actuators overview.						
Module 2	Kinematics and Dynamics	Analyze		L-5 P-5		
Forward and inverse kinematics of humanoid limbs, dynamic modeling, Zero Moment Point (ZMP), balance and stability, gait generation.						
Module 3	Control Systems and Locomotion	Apply		L-6 P-6		
PID control, adaptive control, walking patterns, motion planning, trajectory control, joint and whole-body motion coordination.						
Module 4	Perception, AI, and Human-Robot Interaction			L-7 P-6		

Vision and auditory perception, sensor fusion, machine learning for humanoid behavior, speech recognition, emotional interaction, safety and ethical issues.

TEXTBOOKS;

1. John-Joseph Cabibihan et al., "Handbook of Humanoid Robotics", Springer, 2019.

2. Illah R. Nourbakhsh and Roland Siegwart, "Introduction to Autonomous Mobile Robots", MIT Press, 2011.

REFERENCE MATERIALS:

1. Hartmut Surmann, "Humanoid Robotics: A Reference", CRC Press, 2017.

2. Sabine Hauert and Auke Ijspeert, "Robotics: Science and Systems" (various volumes).

REFERENCES

JOURNALS/MAGAZINES

SWAYAM/NPTEL/MOOCs:

<table>
<tr><td>Course Code:

MEC3411</td><td colspan="3">Course Title: Robotics

Type of Course:

1]Professional Elective Course

2] Theory</td><td>L-T-P-C</td><td>3-0-0-3</td></tr>
<tr><td>Version No.</td><td colspan="5">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="5">NIL</td></tr>
<tr><td>Anti-requisites</td><td colspan="5">NIL</td></tr>
<tr><td>Course Objective</td><td colspan="5">The objective of the course is to familiarize the learners with the concepts of “Robotics” and attain EMPLOYABILITY SKILL through Participative learning techniques.</td></tr>
<tr><td>Course Description</td><td colspan="5">Robotics and stimulate their interests in science and engineering through the participation of the entire engineering design process. This course provides an overview of robot mechanisms, dynamics, and intelligent controls.</td></tr>
<tr><td>Course Out Comes</td><td colspan="5">On successful completion of the course the students shall be able to:

1. Apply the concepts of inverse manipulator kinematics to a robot.

2. Apply the concepts of kinetics and kinematics to a robot.

3. Choose a suitable trajectory generation scheme for robot tasks.

4. Identify the types of sensors used in various applications.</td></tr>
<tr><td>Course Content:</td><td colspan="5"></td></tr>
<tr><td>Module 1</td><td>Industrial Robots and Their Applications</td><td>Assignment</td><td colspan="2">Problem on DOF, Manipulator.</td><td>12 Sessions</td></tr>
<tr><td colspan="6">Topics:

Introduction to robotics, classification of robots, workspace analysis, Manipulator Kinematics: Convention for affixing frames to links – DH Representation, Derivation of Direct kinematic equations for various types of robots. Inverse Manipulator Kinematics: Solvability, algebraic vs. geometric, Examples of inverse manipulator kinematics, repeatability and accuracy.</td></tr>
<tr><td>Module 2</td><td>Kinematics of Robot</td><td>Assignment</td><td colspan="2">Jacobians, rigid body, dynamic study</td><td>12 Sessions</td></tr>
<tr><td colspan="6">Topics:

Jacobians: Velocities and static forces: Linear and rotational velocity of rigid bodies, velocity propagation from link to link, jacobians, singularities, static forces in manipulators, jacobians in force domain, Cartesian transformation of velocities and static forces.</td></tr>
<tr><td>Module 3</td><td>Trajectory Planning</td><td>Assignment</td><td colspan="2">Trajectory analysis</td><td>12 Sessions</td></tr>
<tr><td colspan="6">Trajectory Generation: General consideration in path description and generation, joint space schemes, collision free path planning, Robot programming.</td></tr>
<tr><td>Module 4</td><td>ROS</td><td>Case Study</td><td colspan="2">Study different types of sensor</td><td>10 Sessions</td></tr>
</table>

ROS: Introduction, ROS - Services, Actions, Launch Files, Building your own ROS environment, Autonomous Navigation, Manipulation, Robot Vision, Design: Blender Introduction
Targeted Application & Tools that can be used: Industrial applications of robots: Pick and place robots, welding and other industrial applications. Automation in industries.
Text Book: 1. Robert J Schilling: Fundamentals of Robotics, Analysis and Control. Prentice Hall of India, 1996. 2. Gonzalez / Woods, Digital Image Processing, Addison Wesley, 1993. 3. R K Mittal and I J Nagrath: Robotics and control. 4. S K Saha: Introduction to Robotics.
References: 1. K S Fu R C Gonzales, C S G Lee: Robotics Control, Sensing, Vision and intelligence, McGraw Hill 1987. 2. John J Craig, Introduction to Robotics, Mechanics and control, second edition Addison – Wesley, 1999. 3. Mark W Spong & M Vidyasagar, Robot Dynamics and Control, John Wiley & Sons, 1989. 4. R P Paul: Robot Manipulators Mathematics Programming, Control, The computer control of robotic manipulators, The MIT Press 1979. 5. Web Resources: W1- https://nptel.ac.in/courses/112105249 W2- https://puniversity.informaticsglobal.com/login?qurl=https://search.ebscohost.com%2flogin.aspx%3fdirect%3dtrue%26db%3dnlebk%26AN%3d1223875%26site%3dehost-live%26ebv%3dEB%26ppid%3dpp_xiii W3- https://www.knimbus.com/user#/searchresult?searchId=Robotics&_t=1663561891101
Topics relevant to “EMPLOYABILITY SKILLS”: Trajectory Generation: General consideration in path description and generation, joint space schemes, collision free path planning, Robot programming for developing EMPLOYABILITY SKILLS through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Course Code: EEE3015	Course Title: Industrial Automation with PLC and SCADA Type of Course: Professional Elective Course	L-T-P- C	3	0	0	3
Version No.	1.0					

Course Pre-requisite	EEE1200 - Basics of Electrical and Electronics Engineering			
Anti-requisites	NIL			
Course Description	This course deals with PLC hardware/software and their importance in automation. SCADA deals with communication protocols and real-time control of power systems using EMS. The course is both conceptual and analytical in nature. It develops programming and simulation skills.			
Course Objective	The objective of the course is to familiarize the learners with the concepts of Industrial Automation with PLC and SCADA and attain Employability Skills through Problem Solving techniques.			
Course Outcomes	On successful completion of this course the students shall be able to: Describe the Internal organization, operation of PLC and I/O Devices. Compute the various ladder diagram and instruction set programming language. Explain the concept of SCADA, DCS and its features. Develop the system by interfacing peripheral devices with PLC, SCADA and DCS applications.			
Course Content:				
Module 1	Introduction to Programmable Logic Controllers:	Assignment	List all the PLC applications in industries like Siemens, ABB, Schneider Electric	10 Sessions
Topics: Introduction to industrial Automation, Advantages & disadvantages of PLC with respect to relay logic, PLC architecture, Input Output modules, PLC interfacing with plant, memory structure of PLC.				
Module 2	PLC Programming Methodologies:	Assignment	Programming	10 Sessions
Topics: Ladder diagram, STL, functional block diagram, SFC, Instruction List. Creating ladder diagram from process control descriptions, Introduction to IEC61131 international standard for PLC.				
Module 3	Introduction to SCADA and DCS	Assignment	Simulation	10 Sessions
Topics: Introduction, Types, features, Data acquisition, Manufacturers system, Evolution of SCADA, Communication Technologies, Monitoring and Supervisory Functions. DCS Specifications, Configuration and Programming.				
Module 4	Industrial Applications of PLC and SCADA	Case study	Simulation	10 Sessions
Topics: SCADA Applications in Power System, Water Utilities and Sewage, Building facilities, Oil and Gas Industries, Communication Network, Industrial Plants and Process Control, Railway Traction and Traffic signals.				
Targeted Application is	Siemens, ABB, Power-grid, Yokogawa Electric			

Tools that can be used: NI Lab-VIEW , Siemens Step 7-Micro/Win 32, S7-200 PLC
Text Books 1. W.Boldon, 'Programmable logic controllers', 5th Edition, Elsevier India Pvt. Ltd., New Delhi, 2011. 2. Stuart A.Boyer, "SCADA: 'Supervisory control and Data Acquisition', 4th Edition, ISA, 2010.
References 1. Robert Radvanovsky, Jacob Brodsky, "Handbook of SCADA/Control Systems Security", 2nd edition, CRC press, 2016. 2. G. K. McMillan, Douglas Considine, "Process/Industrial Instruments Hand book", 5th edition, McGraw Hill, New York, 2009. Online learning resources Case study https://presiuniv.knimbus.com/user#/home Seminar https://presiuniv.knimbus.com/user#/home https://electrical-engineering-portal.com/resources/plc-programming-training https://www.plcacademy.com/ Ebook:https://electrical-engineering-portal.com/download-center/books-and-guides/electrical-engineering/plc-book
Topics relevant to development of "EMPLOYABILITY SKILL": PLC programming, SCADA for developing Employability Skills through Problem solving techniques. This is attained through assessment component mentioned in course Plan.

Course Code: **CSE2279**	**Course Title: Data Structures and Analysis of Algorithm Lab** **Type of Course: Lab**	**L- T-P- C**	0-0-2-1
Version No.			
Course Pre-requisites	**NIL**		
Anti-requisites	**NIL**		
Course Description	This course introduces the concepts of abstract data types, data structures, and algorithm design techniques. Students will learn to represent data using arrays, linked lists, stacks, queues, trees, heaps, graphs, and hash tables, and analyze their time and space complexities. Emphasis is placed on the development of efficient algorithms and their correctness using Big-O, Big-Theta, and Big-Omega notations. Students will also explore algorithmic paradigms such as divide-and-conquer, greedy methods, and dynamic programming.		
Course Objective	To understand and implement fundamental data structures such as arrays, linked lists, stacks, queues, trees, heaps, hashing, and graphs. To analyze the time and space complexity of algorithms using asymptotic notations and solve recurrence relations for algorithm performance evaluation.		

	To design and apply efficient algorithmic techniques including divide-and-conquer, greedy methods, and dynamic programming for solving real-world computational problems.
Course Outcomes	Upon successful completion of this course, students will be able to: **CO1**: Implement fundamental linear and non-linear data structures such as arrays, linked lists, stacks, queues, trees, heaps, and graphs using a programming language. *(Skill Level: Apply)* **CO2**: Analyze and compare the performance of algorithms using empirical methods such as time and space measurements. *(Skill Level: Analyze)* **CO3**: Apply algorithmic techniques such as divide-and-conquer, greedy methods, and dynamic programming to solve computational problems. *(Skill Level: Apply)* **CO4**: Develop modular and well-structured programs to solve real-world problems using appropriate data structures and algorithms. *(Skill Level: Create)*
Course Content:	**List of Laboratory Experiments:**

Exp. No.	Title	Learning Outcome
1	**Analysis of Algorithms –** Measure execution time and space usage of simple recursive vs. iterative algorithms	Understand empirical analysis and performance measurement
2	**Array and String Operations** – Implement insertion, deletion, search, and reverse operations	Gain proficiency in linear data manipulations
3	**Linked Lists (Singly, Doubly, Circular) –** Create and manipulate linked lists with dynamic memory allocation	Understand pointer-based dynamic data structures
4	**Stacks and Queues using Arrays and Linked Lists** – Implement push/pop/enqueue/dequeue operations	Apply stack/queue in real-life problem-solving
5	**Applications of Stack –** Infix to postfix conversion, expression evaluation	Apply stacks in arithmetic expression evaluation
6	**Applications of Queue –** Simulation of round-robin scheduling using circular queue	Simulate process scheduling scenarios
7	**Binary Tree Traversals –** Preorder, Inorder, Postorder (Recursive & Iterative)	Learn various tree traversal strategies

	8	**Binary Search Tree (BST) –** Construct BST, insert, delete, and search operations	Analyze BST behavior with different datasets
	9	**AVL Trees / Balanced BST –** Implement insertions and rotations	Understand tree balancing for efficient searching
	10	**Heap and Heap Sort –** Implement min-heap, max-heap and perform heap sort	Learn priority queue operations and sorting
	11	**Hashing Techniques –** Implement hash tables with collision resolution (linear probing, chaining)	Understand the trade-offs in hashing and lookup efficiency
	12	**Graph Representations and Traversals –** Adjacency list/matrix, BFS and DFS	Solve problems involving connectivity and traversal
	13	**Shortest Path Algorithms –** Implement Dijkstra's and/or Bellman-Ford algorithm	Solve optimization problems using graph algorithms
	14	**Divide and Conquer Techniques –** Implement Merge Sort and Quick Sort	Compare recursive sorting strategies with performance analysis
	15	**Dynamic Programming and Greedy Techniques –** 0/1 Knapsack, Matrix Chain Multiplication, Kruskal's or Prim's	Learn and apply problem-solving paradigms

Text Books :**Sartaj Sahni, Ellis Horowitz**, *Fundamentals of Data Structures and Algorithms*, Universities Press, 2nd Edition, 2021. ISBN: 9788173716615

Reference Books

1. **Thomas H. Cormen et al.**, *Introduction to Algorithms*, MIT Press, 3rd Edition, 2009. ISBN: 9780262033848
2. **Mark Allen Weiss**, *Data Structures and Algorithm Analysis in C++*, Pearson, 4th Edition, 2014. ISBN: 9780132847377
3. **Narasimha Karumanchi**, *Data Structures and Algorithms Made Easy*, CareerMonk Publications, 2nd Edition, 2021. ISBN: 9788193245279