

MALNAD COLLEGE OF ENGINEERING, HASSAN
(An Autonomous Institution Affiliated to VTU, Belagavi)



Autonomous Programme

Bachelor of Engineering



Department of
Robotics & Artificial Intelligence

SCHEME and SYLLABUS
(2025 Admitted Batch)

Academic Year 2026-27



MALNAD COLLEGE OF ENGINEERING, HASSAN
(An Autonomous Institution Affiliated to VTU, Belagavi)
DEPARTMENT OF ROBOTICS & ARTIFICIAL INTELLIGENCE

VISION OF THE INSTITUTE

To be an institute of excellence in engineering education and research, producing socially responsible professionals.

MISSION OF THE INSTITUTE

1. Create conducive environment for learning and research
2. Establish industry and academia collaborations
3. Ensure professional and ethical values in all institutional endeavors

VISION OF THE DEPARTMENT

To be a center of excellence in Robotics and Artificial Intelligence, nurturing competent and ethical engineers who integrate hardware and software to design intelligent, autonomous systems and innovative solutions for the betterment of society.

MISSION OF THE DEPARTMENT

- To impart strong fundamentals in robotics, artificial intelligence and computational mathematics through quality teaching-learning and modern infrastructure.
- To provide hands-on, industry-aligned learning through projects and internships, fostering research and innovation in emerging technologies for developing autonomous systems that address real-world needs.
- To inculcate professional ethics, lifelong learning, communication, teamwork and employability skills for the holistic development of graduates and their responsible contribution to industry and society.



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PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Acquire strong fundamentals and expertise in basic sciences, computing, artificial intelligence and robotics, and apply them to design, build and deploy intelligent and autonomous systems, excelling as a professional or an entrepreneur.

PEO2: Pursue higher studies and engage in research and innovation in emerging areas such as machine learning, IoT, embedded intelligence and autonomous systems to address real-world needs.

PEO3: Adapt to technological advancements through lifelong learning and exhibit professional ethics, effective communication, teamwork and leadership for responsible contribution to industry and society.

PROGRAM OUTCOMES (POs)

1. **Engineering knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
3. **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. (WK5)
4. **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. (WK8).
5. **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. (WK2 and WK6)
6. **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. (WK1, WK5, and WK7).



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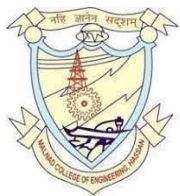
PROGRAM OUTCOMES (POs)

1. **Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
2. **Individual and collaborative team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary settings.
3. **Communication:** Communicate effectively and inclusively within the 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.
4. **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.
5. **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. (WK8)

PROGRAM SPECIFIC OUTCOMES

PSO1 : Robotics and Intelligent Systems Design: Apply principles of robotics, artificial intelligence and machine learning, integrating hardware and software, to design and develop intelligent, autonomous robotic systems for real-world applications.

PSO2 : AI and Data-Driven Problem Solving: Utilize artificial intelligence, machine learning, computer vision and data engineering skills to build, analyse and deploy intelligent solutions that solve complex engineering and societal problems.



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PBNo.21, HASSAN-573201, Karnataka, India

CIE and SEE Assessment Structure for 2025 batch onwards

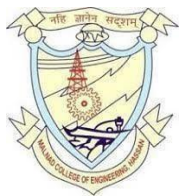
Examination	Maximum Marks	Minimum marks to qualify
CIE	50	20 (12+8)
SEE	50	20
Total	100	40

Assessment Structure for Theory Courses

Assessment	Marks
CIE 1 – conducted for 50 marks and scaled down to 15 marks	15
CIE 2 – conducted for 50 marks and scaled down to 15 marks	15
Activities as decided by course faculty	20
SEE – conducted for 100 and scaled down to 50	50
Total	100

CIE Assessment Structure

Assessment	Marks	Syllabus
CIE 1 - Conducted for 50 marks and scaled down to 15 marks	15	Module-1 and Module-2
CIE 2 - Conducted for 50 marks and scaled down to 15 marks	15	Module-3 and Module-4
Activities as decided by course faculty	20	All Modules
Total	50	



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CIE 1 Question Paper Pattern

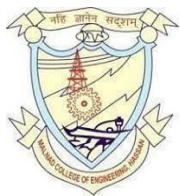
Question 1	Module-1	Mandatory	One question for 20 marks – maximum 4 sub divisions
Question 2	Module-2	Internal choice	Two questions for 20 marks each, out of which, student has to answer one question – maximum 4 sub divisions
Question 3	Module-1 and Module-2	Mandatory	One question for 10 marks – maximum 5 sub divisions – short answer types

CIE 2 Question Paper Pattern

Question 1	Module-3	Mandatory	One question for 20 marks – maximum 4 sub divisions
Question 2	Module-4	Internal choice	Two questions for 20 marks each, out of which, student has to answer one question – maximum 4 sub divisions
Question 3	Module-3 and Module-4	Mandatory	One question for 10 marks – maximum 5 sub divisions – short answer types

SEE Question Paper Pattern

Question 1	Module -1	Mandatory	One question for 20 marks – maximum 4 sub divisions
Question 2	Module -2	Internal choice	Two questions for 20 marks each, out of which, student has to answer one question - maximum 4 sub divisions
Question 3	Module -3	Internal choice	Two questions for 20 marks each, out of which, student has to answer one question - maximum 4 sub divisions
Question 4	Module -4	Internal choice	Two questions for 20 marks each, out of which, student has to answer one question - maximum 4 sub divisions
Question 5	Module – 1, 2, 3, 4	Mandatory	One question for 20 marks – maximum 5 sub divisions – short answer types



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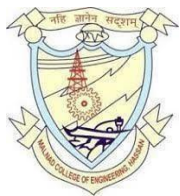
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Assessment Structure for Exclusive Laboratory Courses

Assessment	Marks	Minimum marks to qualify
Continuous Evaluation in every lab session by the Course Coordinator	30	12
Laboratory CIE - conducted for 50 marks and scaled down to 20	20	8
SEE	50	20
Total	100	40

1. The laboratory syllabus shall consist of PART-A and PART-B. PART-A has shall have minimum of 10 fixed set of experiments. PART-B shall have minimum of 10 open-ended experiments.
2. Open-ended experiments are a type of laboratory activity where the outcome is not predetermined and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning.
3. Both PART-A and PART-B are considered for CIE and SEE.
4. Students have to answer 1(one) question from PART-A and 1(one) question from PART-B.
5. The questions for CIE and SEE shall be included from among the experiments under PART-A and shall be evaluated for 25 marks out of the maximum 50 marks.
6. The open-ended question set for CIE and SEE shall be any other open-ended question not done in regular lab sessions under PART-B and shall be evaluated for 25 marks out of the maximum 50 marks.
7. The student shall be evaluated in every lab session for 30 marks and finally the average of all evaluations shall be considered as continuous evaluation for 30 marks.



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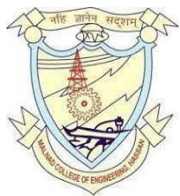
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Assessment Structure for Integrated Laboratory Courses (20 Marks)

Assessment	Marks	Minimum marks to qualify
Continuous Evaluation in every lab session by the Course Coordinator	30	12
Laboratory CIE - conducted for 50 marks and scaled down to 20	20	8
Total	50	20
*** Integrated Lab Course marks shall be scaled down to 20		

1. The laboratory syllabus shall consist of PART-A and PART-B. PART-A has shall have minimum of 10 fixed set experiments. PART-B shall have minimum of 10 open-ended experiments.
2. Open-ended experiments are a type of laboratory activity where the outcome is not predetermined and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning.
3. Both PART-A and PART-B are considered for CIE.
4. Students have to answer 1(one) question from PART-A and 1(one) question from PART-B.
5. The questions for CIE shall be included from among the experiments under PART-A and shall be evaluated for 25 marks out of the maximum 50 marks.
6. The open-ended question set for CIE shall be any other open-ended question not done in regular lab sessions under PART-B and shall be evaluated for 25 marks out of the maximum 50 marks.
7. The student shall be evaluated in every lab session for 30 marks and finally the average of all evaluations shall be considered as continuous evaluation for 30 marks.



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Rubrics for Continuous Evaluation in Laboratory Courses **(30 marks)**

Performance Indicators	Excellent	Very Good	Good	Satisfactory
Fundamental Knowledge : Understanding the problem statement (4 Marks)	The student has in-depth knowledge of the topics related to the course (4)	Student has good knowledge of some of the topics related to course (3)	Student is capable of narrating the answer but not capable to show in depth knowledge (2)	Student has not understood the concepts clearly (1)
Design Of Experiment (5 Marks)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable design with proper reason (5)	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best (4)	Student is capable of discussing single design with its merits and demerits (2-3)	Student is capable of explaining the design (1)
Implementation (8 Marks)	Student is capable of implementing the design with best suitable algorithm considering optimal solution. (7-8)	Student is capable of implementing the design with best suitable algorithm and should be capable of explaining it (5-6)	Student is capable of implementing the design with proper explanation. (3-4)	Student is capable of implementing the design. (1-2)
Result & Analysis (5 Marks)	Student is able to run the program on various cases and compare the result with proper analysis. (5)	Student will be able to run the program for all the cases. (4)	Student will be able to run the code for few cases and analyze the output. (2-3)	Student will be able to run the program but not able to analyze the output. (1)
Demonstration and Documentation (8 Marks)	Demonstration is very good. The lab record is well organized, with clear sections (e.g., Introduction, Method, Results, and Conclusion). Transitions	Demonstration is good. The lab record is organized, with clear sections, but some sections are not well defined. (5-6)	Demonstration is not clear. The lab record lacks clear organization or structure. Some sections are unclear or incomplete. (3-4)	Demonstration is very poor. The lab record is poorly organized, with missing or unclear sections. (1-2)



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between sections
are smooth. (7-8)

Rubrics for CIE/SEE Test in Laboratory Courses

Performance Indicators	Superior(5)	Good(4)	Fair(3)	Needs Improvement(2)	Unacceptable(1)
Understanding of Experimental Principle	Excellent	Good	Satisfactory	Limited	Poor
Experimental Execution	Independent execution	Minor procedural errors	With guidance	Significant errors	Unable
Observation, Result & Interpretation	Accurate and scientific	Minor errors	Basic	Limited	Incorrect
Open-ended Problem Solving	Independent design	Good approach	Basic solution	Limited	Unable
Viva Voce & Scientific Communication	Excellent	Good	Satisfactory	Limited	Unable



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COURSE TYPES

Basic Science Course	BSC
Applied Science Course	ASC
Engineering Science Course	ESC
Emerging Technology Course	ETC
Programming Language Course	PLC
Professional Core Course	PCC
Integrated Professional Core Course	IPCC
Professional Core Course Laboratory	PCCL
Professional Elective Course	PEC
Open Elective Course	OEC
Project/Mini Project/Internship	PI
Humanities and Social Sciences, Management Course	HSMC
Ability Enhancement Course	AEC
Skill Enhancement Course	SEC
Skill Development Course	SDC
Universal Human Value Course	UHV
Non-credit Mandatory Course	MC



THIRD SEMESTER												
Sl. No	Course Category	Course Code	Course Title	Teaching Hours/Week					Exam Marks			Credits
				L	T	P	TW & SL	TH/S	CIE	SEE	Total	
1	BSC	25RA301	Discrete Mathematics & Probability Theory	42	28	0	50	120	50	50	100	4
2	IPCC	25RA302	Data Structures and Algorithms	42	0	28	50	120	50	50	100	4
3	IPCC	25RA303	Mechanics of Materials	42	0	0	48	90	50	50	100	3
4	PCC	25RA304	Digital Systems for Robotics & AI	42	0	0	48	90	50	50	100	3
5	PCC	25RA305	Fundamentals of Industrial Robots	42	0	0	48	90	50	50	100	3
6	PCCL	25RAL306	Digital Systems for Robotics & AI LAB	0	0	28	2	30	50	50	100	1
7	AEC	25RAL307	Computer Aided Modelling Lab	0	0	28	2	30	50	50	100	1
8	SDC	25SCR	Community Project (Project-Based Learning/Societal Project)	0	0	0	30	30	50	50	100	1
9	AEC	25PT1	Placement Training I	14	0	0	16	30	50	50	100	A
10	NCMC	25NYP1	NSS / Yoga / PE / Music	0	0	0	28	28	100	-	100	A
11	NCMC	25BCM301	Bridge Mathematics –I (Non-Credit Mandatory Audit Course for Diploma entry Students)	14	0	0	14	28	100	-	100	A
Total												20



FOURTH SEMESTER												
Sl. No	Course Category	Course Code	Course Title	Teaching Hours/Week					Exam Marks			Credits
				L	T	P	TW & SL	TH/S	CIE	SEE	Total	
1	PCC	25RA401	Robot Kinematics & Dynamics	42	0	0	48	90	50	50	100	3
2	IPCC	25RA402	Object-Oriented Programming	42	0	28	50	120	50	50	100	4
3	PCC	25RA403	Control Systems	42	0	0	48	90	50	50	100	3
4	PCC	25RA404	Sensors and Actuators	42	0	0	48	90	50	50	100	3
5	PCC	25RA405	Design of Robotic Components	28	28	0	34	90	50	50	100	3
6	PCCL	25RAL406	Sensors & Actuators Lab	0	0	28	2	30	50	50	100	1
7	AEC	25RAL407	Industrial Robot Lab	0	0	28	2	30	50	50	100	1
8	BSC	25RA408	Biology for Engineers	14	0	0	16	30	50	50	100	1
9	SDC	25EVS	Environmental Science Project	0	0	0	30	30	50	50	100	1
10	AEC	25PT2	Placement Training II	14	0	0	16	30	50	50	100	A
11	NCMC	25NYP2	NSS / Yoga / PE / Music	0	0	0	28	28	100	-	100	A
12	NCMC	25BCM301	Bridge Mathematics –I (Non-Credit Mandatory Audit Course for Diploma entry Students)	14	0	0	14	28	100	-	100	A
Total												20

Total



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FIFTH SEMESTER												
Sl. No	Course Category	Course Code	Course Title	Teaching Hours/Week					Exam Marks			Credits
				L	T	P	TW & SL	TH/S	CIE	SEE	Total	
1	HSMC	25RA501	Management and Economics	42	0	0	48	90	50	50	100	3
2	IPCC	25RA502	AI & Machine Learning for Robotics	42	0	28	50	120	50	50	100	4
3	PCC	25RA503	Robot Operating System	42	0	0	48	90	50	50	100	3
4	PCC	25RA504	Microcontrollers & and applications	42	0	28	50	120	50	50	100	4
5	PEC	25RA505x	Professional Elective-I	42	0	0	48	90	50	50	100	3
6	BSC	25RA506	Research Methodology & IPR	42	0	0	48	90	50	50	100	3
7	PCCL	25RAL507	Robot Operating System Lab	0	0	28	2	30	50	50	100	1
8	SDC	25RA508	Hackathon-Based Project	0	0	0	30	30	50	50	100	1
9	AEC	25PT3	Placement Training III	0	0	2		2	50	50	100	1
Total												23

Professional Elective-I (V Semester)	
25RA505A: Finite Element Methods	25RA505B: Computer Vision Fundamentals
25RA505C: Digital Twin Technology	25RA505D: Cyber Security



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SIXTH SEMESTER

Sl. No	Course Category	Course Code	Course Title	Teaching Hours/Week					Exam Marks			Credits
				L	T	P	TW & SL	TH/S	CIE	SEE	Total	
1	IPCC	25RA601	Deep and Reinforcement Learning	42	0	28	50	120	50	50	100	4
2	IPCC	25RA602	Natural Language Processing	28	0	28	34	90	50	50	100	3
3	PCC	25RA603	Autonomous Robots	42	0	0	48	90	50	50	100	3
4	PCC	25RA604	Edge Computing & Cognitive Intelligence	42	0	0	48	90	50	50	100	3
5	PEC	25RA605x	Professional Elective-II	42	0	0	48	90	50	50	100	3
6	PCCL	25RAL606	Edge Computing & Cognitive Intelligence Lab	0	0	28	2	30	50	50	100	1
7	AEC	25RAL607x	Deep Learning Lab	0	0	28	2	30	50	50	100	1
8	AEC	25PT4	Placement Training IV	14	0	0	16	30	50	50	100	1
9	NCMC	25UHV	Universal Human Values (VTU online Course)	14	0	0	16	30	100	-	100	A
10	PI	25PRJ1	Capstone Project – Phase I	0	0	0	90	90	50	50	100	3
Total												22

Professional Elective-II (VI Semester)

25RA605A: Data Analytics & Visualization	25RA605B: Cloud Computing & DevOps
25RA605C: Robot-Integrated Manufacturing	25RA605D: Virtual Instrumentation & SCADA



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SEVENTH SEMESTER

Sl. No	Course Category	Course Code	Course Title	Teaching Hours/Week					Exam Marks			Credits
				L	T	P	TW & SL	TH/S	CIE	SEE	Total	
1	IPCC	25RA701	Industrial Internet of Things	42	0	28	50	120	50	50	100	4
2	PEC	25RA702x	Professional Elective-III	42	0	0	48	90	50	50	100	3
3	PEC	25RA703x	Professional Elective-IV	42	0	0	48	90	50	50	100	3
4	OEC	25RA704x	Open Elective-I	42	0	0	48	90	50	50	100	3
5	PI	25PRJ2	Capstone Project – Phase II	0	0	0	210	210	100	100	200	7
6	NCMC	25IKS	Indian Knowledge System	14	0	0	16	30	100	-	100	A
Total												20

Professional Elective-III (VII Semester)

25RA702A: Robot Process Automation (RPA)	25RA702B: Operations Research
25RA702C: Mobile Application Development for Robots	25RA702D: Trustworthy & Explainable AI for Robotics

Professional Elective-IV (VII Semester)

25RA703A: Business Analytics	25RA703B: MEMS & Nanotechnology for Robots
25RA703C: Agentic AI & Multi-Agent Systems	25RA703D: Wireless Communication & 5G

Open Elective-I (VII Semester)

25RA704A: Autonomous Mobile Robots	25RA704B: Industrial Automation
25RA704C: Introduction to Robotics	25RA704D: Foreign Language (NPTEL/SWAYAM/VTU Online)



EIGHTH SEMESTER

Sl. No	Course Category	Course Code	Course Title	Teaching Hours/Week					Exam Marks			Credits
				L	T	P	TW & SL	TH/S	CIE	SEE	Total	
1	PEC	25SW01	Professional Elective-V (NPTEL/Online)	0	0	0	90	90	50	50	100	3
2	OEC	25SW02	Open Elective-II (NPTEL/Online)	0	0	0	90	90	50	50	100	3
3	PI	25INT	Internship (15 weeks / 90 working days)	0	0	0	0	360	100	100	200	9
Total												15



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Community/Societal Project

A community is a social unit or group of people sharing socially significant characteristics, such as place, set of norms, culture, religion, values, customs or identity. A community project involves addressing issues or needs within such a community or a network of entities working towards a common purpose. These projects may cover a wide range of areas, including welfare, sustainability, technology integration, and social development. Examples include establishing and maintaining an orphanage, implementing solar power generation and its maintenance, or developing environmental improvement solutions, etc. A community project is an experiential learning activity that encourages students to identify, analyze, and address real-life problems of the community using engineering knowledge. It aims to promote social responsibility and civic engagement, interdisciplinary thinking and collaboration and practical application of theoretical concepts, thereby enabling students to contribute meaningfully to community welfare and sustainable development. Students can take up projects individually or in a group not exceeding 4 students.

Environmental Science Project

The Environmental Science Project is an applied learning component designed to develop students' awareness, understanding, and responsibility toward the environment. It provides an opportunity to study real-world environmental issues and apply scientific and engineering principles to design feasible and sustainable solutions. The topics under environment include, but not limited to, climate change, biodiversity, air and water pollution, land use, excess use of natural resources, earthquakes, rise in the earth's temperature, power generation, soil erosion, environment issues related programme, etc. The project involves problem identification, field surveys, case studies, data collection, environmental audits, analysis, and proposal of remedial or preventive measures aimed at improving biodiversity, air quality, and thermal comfort, etc. Students can take up projects individually or in a group not exceeding 4 students. Students can opt for Interdisciplinary Project based on their interest.

Hackathon Based Project

The term hackathon is derived from the combination of hack (referring to clever problem-solving, not illegal activity) and marathon, which denotes an arduous (i.e., difficult) intellectual task requiring sustained effort, endurance, and mental resilience. The meaning of a hackathon varies depending on the specific context and intent. In an academic context, a hackathon can be considered to involve several concepts, ranging from resourceful, unconventional approaches to problem-solving. Though a hackathon is an event, typically lasting for a few days to address a specific challenge, for academic purposes, it is conducted as a noncompetitive semester-long activity. The evaluation is done as and when the project is completed, by a panel of industry experts. The hackathons not only help participants develop skills like problem-solving, critical thinking, creativity, teamwork, communication and time management, but also foster indigenous technology development, promote innovation and entrepreneurship, and contribute to non-formal learning and skill enhancement. Students can take up a hackathon project individually or in a group of not exceeding 4 students.

The respective BoS will announce the problem statements in the beginning of the 5th semester. The topic selected can be discipline specific, interdepartmental, industrial, social (refers to immediate human relations, interactions, and individual behavior within a community), societal (describes larger, general issues, institutions, and structures that define society as a whole), environmental, health, financial, or innovative in nature, leading to development of a working prototype, application, or product. Hackathon projects are aligned with the principles of Outcome-Based Education (OBE) and support the objectives of innovation, skill development, and experiential learning in engineering education. Projects shall be evaluated by industry experts, based on creativity, problem-solving approach, teamwork, and possible implementation, as far as possible, as and when the project is completed.



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Capstone Project

The Capstone project is a comprehensive, year-long project carried out in two phases during 6th and 7th semesters of the undergraduate engineering/technology program. It integrates knowledge and skills acquired from multiple courses and disciplines to address a complex, real-world problem.

This project provides students with an opportunity to apply scientific principles, engineering methodologies, and technological tools to conceive, design, implement and evaluate an engineering

solution. It serves as a culminating academic experience to demonstrate program outcomes, including problem-solving ability, teamwork, communication skills, and practical application of engineering principles. Students can take up projects individually or in a group not exceeding 4 students. The group may have students from the same discipline and drawn from different disciplines.

Types of Capstone Projects: Capstone projects undertaken for one year may fall into one or more of the following categories:

a) Research-Oriented Projects

- Focus on investigating new concepts, theories, or technologies.
- Aim to generate new knowledge or contribute to academic research.

b) Experimental/Analytical Projects

- Based on laboratory or field experiments to validate a hypothesis or study a phenomenon.
- Including detailed data collection, analysis, and interpretation.

c) Simulation/Modelling Projects

- Use computational tools to model, simulate, and predict system behavior.
- Reduce the need for physical prototyping in the initial stages.

d) Industrial/Industry-Sponsored Projects

- Carried out in collaboration with an industry partner, address real-world engineering problems faced by the organization.

e) Interdisciplinary/Multidisciplinary Projects

- Combine knowledge and techniques from multiple engineering domains or other fields such as management, medicine, or environmental sciences.

f) Entrepreneurial/Innovation Projects

- Focus on product or service innovation with potential for commercialization.
- Include aspects of market analysis, cost estimation, and business planning.



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Course Title	Discrete Mathematics and Probability Theory		
Course Code	25MARA301	LTPC	(3-0-0)3
Exam	03 Hours	Hours / Week	3
SEE	50 Marks	Total hours	42L+48ABL=90

Course Objective: To introduce the students to probability and statistics for Mechanical Engineering through an understanding of the descriptive statistics and probability to analyze distributions and relationship of real-time data.

Course Outcomes (COs): {with mapping shown against the Program Outcomes (POs)}
Upon completion of the course, students shall be able to:

No.	Course Outcomes	Mapping to POs
1.	Apply concepts of mathematical logic, discrete mathematics, probability, and statistical inference to solve mathematical and engineering problems.	1
2.	Analyze mathematical and statistical models using relations, functions, combinatorics, probability distributions, sampling, and hypothesis testing for effective problem-solving and decision-making.	2
3.	Develop mathematical and statistical models for real-life engineering and analytical problems.	2, 3

Module -1	10 Hrs.
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Mathematical Logic

Propositions and logical operations, truth tables, logical equivalence, predicates and quantifiers.

Relations

Relations and their properties, partial order and total order relations Hasse- diagram. Matrix representation of relations, directed graph representation of relations, transitive closure of relations.

Application: Warshall's algorithm.

Self-Study: Methods of proof: Rules of inference, equivalence relations.

Module- 2	11 Hrs.
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Functions

Functions and their types: injective, surjective and bijective functions, composition and inverse functions

Combinatorics

Basic counting principles, permutations and combinations, combinations with repetition. Linear recurrence relations, Principle of Inclusion and Exclusion, generalized inclusion-exclusion, derangements and applications. Generating functions.

Application: Using Inclusion and Exclusion principle devising a system of two- way roads

Self-Study: Catalan numbers and applications, Fibonacci sequence and applications.



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Module- 3	11 Hrs.
Probability Theory and Random Variables One-Dimensional Random Variable: Discrete and Continuous Random Variable, Probability Functions, Cumulative Distribution Function, Expectation and Variance. Discrete and continuous Probability Distributions Binomial, Poisson, Normal and Exponential Distributions Application: AI-based traffic systems, face-recognition system Self-Study : Uniform Distributions	
Module- 4	10 Hrs.
Joint Distribution: Probability Density Function, Marginal Distribution, Expectation, Variance, Covariance and Correlation Sampling Theory- Introduction to sampling distribution Confidence intervals and Hypothesis testing: Testing a hypothesis, central limit theorem, concepts of standard error and confidence interval, level of significance, type I and type II errors, one tailed and two tailed tests, Z-test: for single mean, for single proportion and for difference between means, for difference between proportion. Application: Cloud server performance analysis, Cyber-security login analysis Self-Study: student-t distribution.	

Note – Theorems and properties without proof. Applicable to all the modules. Self-study is not included in SEE

Prescribed Text Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Discrete Mathematics and Its Applications	Kenneth H. Rosen	8th Edition	McGraw-Hill Education	2019
2.	Probability and Statistics for Engineers and Scientists	Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye	9th Edition	Pearson Education	2017

Reference Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Discrete and Combinatorial Mathematics: An Applied Introduction	Ralph P. Grimaldi	5th Edition	Pearson Education	2004
2.	Discrete Mathematics	Seymour Lipschutz and Marc Lipson	3rd Edition	McGraw-Hill Education	2009
3.	Introduction to Probability Models	Sheldon M. Ross	12th Edition	Academic Press	2019
4.	Probability, Statistics and Random Processes	T. Veerarajan	4th Edition	McGraw-Hill Education	2017
5.	Schaum's Outline of Probability and Statistics	Murray R. Spiegel, John Schiller and R. Alu Srinivasan	4th Edition	McGraw-Hill Education	2013



Sl.No	Teaching and Learning Method	No. of Hours/ Week	No. of Weeks	Hours/ Semester
1	Class Room Teaching & Learning	3	14	42
2	Integrated Lab Component	-	-	-
3	Student Study Hours – Self Learning	-	-	-
4	Tutorial Component	1	14	14
5	Activity Based Learning (ABL1 & ABL2)	-	-	28
6	Evaluation of Learning Process	-	-	06
Total Learning Hours/Semester				90

Tool	Remarks	Marks
CIE	Two CIEs conducted for 50 marks each and reduced to 15 marks	30
Activity Details	Details of activities to be conducted 1) Details of activity1 2) Details of activity2	20
Total		50

	ABL 1 : Activity1 details (14 Hrs)		
	Writing Assignment with Problems on concerned to real world applications.	Submission of the final assignment report and evaluation.(Questions of blooms level L3 and Higher)	14
	ABL 2 : Activity2 details (14 Hrs)		
	Problem Solving Assignment	Understand the input data requirements	1
		Formulate the methodology	3
		Design the solution	4
		Solving the problem and submission	4
Total			14

[illegible]



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Course Title	Data Structures and Algorithms		
Course Code	25RA302	(L-T-P) C	(3 : 0 : 2)4
Exam	3	Hours/Week	5
SEE	50 Marks	Total Hours	42L + 28P+42ABL+8ELP=120
Course Objective: To enable students to analyse algorithms for time and space efficiency, apply linear and non-linear data structures such as arrays, stacks, queues, linked lists, trees, hash tables and graphs, select appropriate algorithm design techniques, and implement efficient C/Python-based solutions for interdisciplinary mechatronics and robotics engineering applications. Course Outcomes: At the end of the course, the student will be able to:			
#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Apply the fundamentals of algorithmic analysis to evaluate time and space complexities and select appropriate linear data structures to solve core engineering problems.	1-4,	1, 2,3
2	Analyse graph representations, traversal algorithms, trees to optimize data retrieval, robotic navigation, and automation network connectivity.	1-4,5	1, 2,3
3	Design comprehensive data structures and algorithms (DSA) architectures tailored for robotics, and interdisciplinary engineering systems.	1-4,5,6,11	1, 2,3
4	Develop and Implement C based DSA solutions for interdisciplinary engineering problems through coding, testing, and proper documentation	1-4,5,8, 9,10, 11	1, 2,3
MODULE-1			10 hours
Introduction, Stacks, Queues: Introduction to data structures and algorithms; algorithm analysis; time and space complexity; arrays and dynamic arrays; applications in sensor buffers and actuator command sequences; stacks and queues; queue applications in job scheduling and sensor streams.			
MODULE-2			10 hours
Linked List, Recursion: Singly linked lists, circular linked lists and doubly linked lists; insertion, deletion and traversal; memory representation; recursion: Factorial, Fibonacci series, Tower of Hanoi; Engineering examples: robot task lists, route checkpoint lists and recursive search problems.			
MODULE-3			12 hours
Trees, Searching and Sorting: Tree terminology; binary trees; binary search trees; tree traversals; heaps and priority queues; Searching and Sorting: Linear search and binary search, bubble sort, selection sort, insertion sort; applications in decision logic, task priority scheduling, sensor-event ranking and hierarchical representation of robotic subsystems.			
MODULE-4			12 hours
Graphs and Navigation: Graph terminology and representations; adjacency matrix and adjacency list; BFS and DFS with computing efficiencies; connected components; shortest path: Dijkstra's Algorithm, Bellman-Ford Algorithm; applications in mobile robot navigation, network connectivity and path planning abstractions.			



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Prescribed Text Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Fundamentals of Data Structures in C	Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed	2 nd Edition	Universities Press	2014
2.	Algorithms	Addison Robert Sedgewick and Kevin Wayne,	4th Edition	Wesley / Pearson	2011
3.	Data Structures Using C	Reema Thareja,	3rd Edition	Oxford University Press	2025

Reference Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Introduction to Algorithms	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein	4th Edition	MIT Press	2022
2.	Data Structures and Algorithm Analysis in C++	Mark Allen Weiss	4th Edition	Pearson	2014
3.	Data Structures: A Pseudo-code Approach with C	Richard F. Gilberg and Behrouz A. Forouzan	2nd Edition	Cengage Learning	2014
4	Data Structures (Schaum's Outlines), Revised	Seymour Lipschutz	1st Edition	McGraw Hill	2014

E-Books and online course materials:

1. MIT OpenCourseWare: Introduction to Algorithms: <https://ocw.mit.edu/courses/6-006-introduction-to-algorithms-spring-2020/>
2. Princeton University: Algorithms, Part I: <https://online.princeton.edu/algorithms-part-i>
3. VisuAlgo: Data Structure and Algorithm Visualization: <https://visualgo.net/>
4. University of San Francisco: Data Structure Visualizations: <https://www.cs.usfca.edu/~galles/visualization/Algorithms.html>

Online Courses and Video Lectures:

1. NPTEL: Data Structures and Algorithms: <https://nptel.ac.in/courses/106102064>
2. NPTEL YouTube Playlist: Data Structures and Algorithms: <https://www.youtube.com/playlist?list=PLBF3763AF2E1C572F>
3. Virtual Labs, IIIT Hyderabad: Data Structures Lab: <https://ds1-iiith.vlabs.ac.in/>
4. Virtual Labs, IIIT Hyderabad: Stacks and Queues Experiment: <https://ds1-iiith.vlabs.ac.in/exp/stacks-queues/index.html>
5. Virtual Labs, IIIT Hyderabad: Linked List Basics: <https://ds1-iiith.vlabs.ac.in/exp/linked-list/basics/overview.html>
6. Virtual Labs, IIIT Hyderabad: Tree Traversal Experiment: <https://ds1-iiith.vlabs.ac.in/exp/tree-traversal/index.html>



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Teaching -Learning– Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/ Week	No. of Weeks	Hours/ Semester
1.	Class Room Teaching & Learning	3	14	42
2.	Integrated Lab Component	2	14	28
3.	Tutorial Component	-	-	-
4.	Open-Ended Experiments	-	-	42
5.	Evaluation of Learning Process	-	-	8
Total Learning Hours / Semester				120

Proposed Assessment Plan (for 50 marks of CIE):

Tool	Remarks	Marks
CIE	Two CIEs conducted for 50 marks each and reduced to 15 marks	30
Integrated Lab Experiments	Lab Program Execution	20
Total		50

Integrated Lab Component (28Hours)

#	List of Experiments
1.	Implement an array-based data processing program to store sensor readings and compute the number of readings, minimum value, maximum value, average value and range using sample data from temperature, water-level, distance or motor-speed sensors.
2.	Design and demonstrate stack operations such as push, pop, peek and display, and apply the stack to reverse actuator commands or verify the correct order of machine-operation steps.
3.	Construct a queue-based task processing program to perform insertion, deletion and display operations for robot movement commands, workshop job scheduling, pump requests or sensor-data buffering.
4.	Implement a singly linked list to perform insertion, deletion, searching and traversal operations for maintaining robot task IDs, machine service records or route checkpoint numbers.
5.	Model a doubly linked list to support insertion, deletion, forward traversal and reverse traversal for representing robot forward–reverse movement, conveyor stations or inspection checkpoints.
6.	Apply recursion to solve selected computational problems such as factorial, Fibonacci series, binary search or Tower of Hanoi, and trace the recursive calls to understand repeated engineering tasks.
7.	Construct a binary search tree and perform insertion, searching, inorder traversal, preorder traversal and post order traversal using component IDs, tool numbers, sensor-event IDs or machine-part codes.
8.	Evaluate linear search and binary search using a list of component numbers, tool IDs, machine IDs or student roll numbers, and compare the number of comparisons required by each method.
9.	Simulate an intelligent warehouse robot navigation system using graph data structures. Represent warehouse locations as graph vertices and pathways as weighted edges. Implement Dijkstra's algorithms to compute the shortest route for autonomous robot movement and efficient package delivery.
10.	Model a simple path or network using graph representation and perform BFS and DFS traversal for robot movement between locations, workshop-station connectivity, warehouse route planning or automation-cell layout.



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PART B	
1.	A shopping mall maintains the IDs of vehicles parked in its parking area. As vehicles enter and leave throughout the day, the parking records need to be updated efficiently. Design and implement a Smart Parking Management System using an arrays.
2.	Design and implement a Library Book Return Management System in C using a Stack.
3.	An organization maintains employee records using unique Employee IDs. To efficiently organize and retrieve employee information. Design an Employee Management System. using a Binary Search Tree.
4.	a) Suppose you want to search a text book in a huge library where books are arranged in alphabetical order. Optimize your search by using recursion. b) Implement Tower of Hanoi problem using recursion.
5.	Consider a traffic signal controlled by a computer system. Traffic signal has three colors: Red, yellow and Green. All these glow in a circular fashion based on the traffic. Implement the above using suitable data structure.
6.	Hospital Patient Token Management Using Queue.
7.	The parking lot has a fixed number of parking spaces. Cars can enter the parking lot and occupy an available space, and they can also exit the parking lot, freeing up the space for other cars. Designing a parking lot management system using a circular queue.
8.	A phonebook stores contact information in ascending alphabetical order based on the contact names to enable efficient organization and retrieval. Each contact consists of a Name and a Phone Number. Design and implement a C program using a Singly Linked List to develop a Phonebook Management System.
9.	Assume you come across a toll gate while you are on your way to home town. Illustrate the working of the toll gate using suitable data structure
10.	A college stores student records using Student IDs as unique keys. To facilitate quick searching and ordered retrieval, the records are maintained using a Binary Search Tree.

Assessment Structure for Integrated Laboratory Courses (20 Marks) :

Assessment	Marks
Continuous Evaluation in every lab session by the Course Coordinator	30
Laboratory CIE - conducted for 50 marks and scaled down to 20	20
Total	50
*** Integrated Lab Course marks shall be scaled down to 20	

Evaluation of Learning Process (9 Hours)

Type of Evaluation	Hours
CIE (1,2)	3
Lab Program Execution	2
Open-Ended Experiments	1
SEE	3
Total	9



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Course Articulation Matrix

Course Outcomes	Program Outcomes											Program Specific Outcomes		
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2	PSO3
CO1	3	3	1	1	-	-	-	-	-	-	-	2	1	1
CO2	3	2	2	1	2	-	-	-	-	-	-	3	2	1
CO3	3	3	3	2	2	1	-	-	-	-	1	3	2	3
CO4	2	2	3	2	3	-	-	1	2	3	2	2	3	3



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Course Title	MECHANICS OF MATERIALS		
Course Code	25RA303	(L-T-P) C	(3 : 0 : 0) 3
Exam	3	Hours/Week	3
SEE	50 Marks	Total Hours	42 L+40ABL+8EV=90
Course Objective: To provide fundamental knowledge of stresses, strains and deformations in engineering materials, enabling students to analyze structural members and machine elements subjected to axial, bi-axial, bending, shear and torsional loads for the safe design of robotic and mechanical systems. Course Outcomes: At the end of the course, the student will be able to:			
#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Apply the concepts of stress, strain, elastic constants and Hooke's law to determine stresses and deformations in simple and compound bars.	1, 2	1
2	Analyze bi-axial stress systems to determine principal stresses and maximum shear stresses using analytical and graphical (Mohr's circle) methods.	1, 2	1
3	Design and develop solutions for beams and structural members by determining shear force, bending moment and bending stress distributions under different loading conditions.	1, 2, 3	1
4	Evaluate the strength and rigidity of beams and circular shafts subjected to shear and torsional loads, and create simulation-based models of real-world structural or machine elements using open-source FEM tools.	1, 2, 3, 5, 9, 10	1
MODULE-1			11 Hours
Simple Stress and Strain: Definition/derivation of normal stress, shear stress, normal strain and shear strain – stress-strain diagram for brittle and ductile materials – Poisson's ratio and volumetric strain. Elastic Constants: Relationship between elastic constants and Poisson's ratio – Hooke's law – deformation of simple and compound bars.			
MODULE-2			10 Hours
Bi-axial Stress System: Introduction, plane stress, stresses on inclined sections, principal stresses and maximum shear stresses. Graphical Method: Mohr's circle for plane stress.			
MODULE-3			11 Hours
Bending Moment and Shear Forces in Beams: Definition of beam – types of beams – concept of shear force and bending moment. S.F. and B.M. diagrams for cantilever, simply supported and overhanging beams subjected to point loads and uniformly distributed loads. Theory of Simple Bending: Assumptions – derivation of bending equation – neutral axis – determination of bending stresses – section modulus of rectangular and circular sections (solid and hollow).			
MODULE-4			10 Hours
Shear Stresses in Beams: Derivation of formula – shear stress distribution across various beam sections like rectangular and circular. Torsion of Circular Shafts: Introduction, pure torsion, assumptions, derivation of torsional equations, polar modulus. Torsional rigidity/stiffness of shafts, power transmitted by solid and hollow circular shafts.			



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Prescribed Text Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Strength of Materials (Mechanics of Solids)	R.K. Rajput	Revised Edition (latest S. Chand reprint)	S. Chand Publishing	2022
2.	Mechanics of Materials	R.C. Hibbeler	11th Edition (SI Edition)	Pearson Education	2024
3.	Strength of Materials	S.S. Bhavikatti	5th Edition	Vikas Publishing House	2023

Reference Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Mechanics of Materials	Ferdinand P. Beer, E. Russell Johnston, John T. DeWolf and David F. Mazurek	8th Edition (SI Edition)	McGraw-Hill Education	—
2.	Mechanics of Materials	James M. Gere and Barry J. Goodno	9th Edition	Cengage Learning	—
3.	Strength of Materials	S. Ramamrutham	18th Revised Edition	Dhanpat Rai Publications	—
4.	Theory of Elasticity	S.P. Timoshenko and J.N. Goodier	3rd Edition	McGraw-Hill	—

Web Links and Video Lectures (e-Resources):



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1. NPTEL: Strength of Materials: https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ce38
2. NPTEL Online Course: https://onlinecourses.nptel.ac.in/e-learning/preview/noc24_me145
3. NPTEL Online Course: https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ce57
4. The Efficient Engineer (YouTube Channel): <https://www.youtube.com/@TheEfficientEngineer>
5. YouTube: Engineering Mechanics Video Lectures:
https://www.youtube.com/results?search_query=engineering+mechanics

Teaching – Learning – Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/Semester
1.	Classroom Teaching & Learning	3	14	42
2.	Tutorial Component	–	–	–
3.	Activity Based Learning (ABL)	–	–	40
4.	Evaluation of Learning Process	–	–	8
Total Learning Hours / Semester				90

Proposed Assessment Plan (for 50 Marks of CIE):

Tool	Remarks	Marks
CIE	Two CIEs conducted for 50 marks each and reduced to 15 marks	30
Activity Details	Activity Based Learning	20
Total		50

Activity Based Learning (40 Hours):

ABL: Analyze, simulate and present the stress and deformation behaviour of a real-world structural or machine element using an open-source simulation tool (FreeCAD FEM Workbench with CalculiX solver)		Hours
1.	Problem Identification	4
2.	Modelling and Simulation of the design using FreeCAD FEM Workbench	30
3.	Report	5
4.	Presentation	1
Total		40



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Evaluation of Learning Process (8 Hours):

Type of Evaluation	Hours
CIE (1, 2)	3
ABL Presentation and Evaluation	2
SEE	3
Total	8

Course Articulation Matrix:

Course Outcomes	Program Outcomes											Program Specific Outcomes		
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	—	—	—	—	—	—	—	—	—	2	—	—
CO2	3	3	—	—	—	—	—	—	—	—	—	2	—	—
CO3	3	3	3	—	—	—	—	—	—	—	—	2	—	—
CO4	3	2	2	—	3	—	—	—	2	2	—	2	—	—



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Course Title	Digital Systems for Robotics & AI		
Course Code	25RA304	(L-T-P) C	(3 : 0 : 0) 3
Exam	3	Hours/Week	3
SEE	50 Marks	Total Hours	42 L+40ABL+8EV=90
Course Objective: To provide foundational knowledge of digital systems, embedded system architecture and Internet of Things (IoT) technologies, enabling students to analyze, design and develop intelligent IoT-based systems for real-world applications. Course Outcomes: Upon completion of the course, students shall be able to:			
#	Course Outcomes	Mapping to PO's	Mappin g to PSO's
1	Apply the principles of digital logic circuits, data processing circuits and sequential circuits in the design of basic digital systems, IoT architectures, communication technologies and protocols.	1	2
2	Analyze the architecture and working principles of embedded systems, microcontrollers, sensors, actuators, data flow and connectivity in IoT systems and embedded platforms used in IoT applications.	1, 2	2
3	Design and develop digital systems, embedded system architectures and IoT-based intelligent solutions for various applications.	1, 2, 3	2
4	Collaborate effectively in teams, demonstrate the working of different neural networks and document the results systematically.	1, 2, 3, 5, 8, 9	1, 2, 3
MODULE-1			11 hours
Digital Logic: The Basic Gates, NOT, OR, AND, Universal Logic Gates, NOR, NAND. Data Processing Circuits: Multiplexers, Demultiplexers, Encoder, Decoder, Magnitude Comparator, Exclusive OR Gates, Parity Generators and Checkers. Introduction to Sequential Circuits – Flip Flops: RS Flip Flop, D Flip Flop, T Flip Flop, JK Flip Flop, JK Master Slave Flip Flop.			
MODULE-2			10 hours
Introduction to Embedded Systems: Definition, Characteristics and Classification of Embedded Systems, Real-Time Embedded Systems. Embedded System Architecture: Basic Components of Embedded Systems, Processor, Memory, Input/Output Interfaces, Buses and Communication Interfaces. Microprocessors and Microcontrollers: Introduction, Comparison between Microprocessors and Microcontrollers, Overview of Embedded Processors and Controllers. Embedded System Programming Concepts: GPIO, Interrupts, Timers and Basic Interfacing Concepts. Embedded Platforms: Introduction to Arduino and Raspberry Pi, Features and Applications. Sensors and Actuators: Introduction, Types of Sensors and Actuators, Interfacing Concepts and Applications in Smart Systems.			



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MODULE-3	11 hours
Introduction to Internet of Things (IoT): Definition, Characteristics, IoT Ecosystem and Applications. IoT Architecture: Physical Design and Logical Design of IoT, IoT Functional Blocks, IoT Communication Models and IoT Levels. IoT Components: Sensors, Actuators, Embedded Devices, Gateways and Cloud Connectivity. IoT Communication Technologies: Wi-Fi, Bluetooth, ZigBee, RFID and NFC. IoT Communication Protocols: MQTT, HTTP and CoAP – Basic Concepts and Applications. IoT System Design: Basic IoT System Architecture and Data Flow in IoT Systems.	
MODULE-4	10 hours
Data Acquisition and Processing in IoT: Data Collection, Data Transmission and Data Storage Concepts. Cloud and Edge Computing: Introduction, Edge Devices and Cloud-Based IoT Systems. Introduction to AI in IoT (AIoT): Intelligent IoT Systems, Smart Devices and Automation Concepts. IoT Analytics and Visualization: Basic Concepts of Data Analytics and Visualization in IoT Systems. IoT Applications: Smart Home, Smart Healthcare, Smart Agriculture, Smart Cities and Industrial IoT. Security and Privacy in IoT: Basic Security Challenges, Privacy Issues and Safe IoT Practices.	

Prescribed Text Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Digital Principles and Applications	Donald P Leach, Albert Paul Malvino and Goutam Saha	3rd Edition	McGraw Hill Education	2015
2.	Embedded Systems: Architecture, Programming and Design	Raj Kamal	3rd Edition	McGraw Hill Education	2012
3.	Internet of Things: A Hands-on Approach	Arshdeep Bahga and Vijay Madisetti	1st Edition	VPT	2016

Reference Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Internet of Things and its Applications	Satish Singh and Shashi Jain	1st Edition	BPB	2020
2.	Digital Design	R. Anantha Natarajan	1st Edition	VPT	2015
3.	IoT based Projects Realization with Raspberry Pi, NodeMCU and Arduino	Dr. Rajesh Singh, Dr. Anita Gehlot, et al.	1st Edition	BPB	2020

E-Books and online course materials:

1. Arduino Language Reference: <https://www.arduino.cc/reference/en>
2. Arduino Project Hub: <https://create.arduino.cc/projecthub>
3. Maker Pro Raspberry Pi Tutorials: <https://maker.pro/raspberry-pi/tutorial>
4. Raspberry Pi Foundation Projects: <https://projects.raspberrypi.org/en/projects>
5. DigiKey: How to Use MQTT with the Raspberry Pi:
<https://www.digikey.com/en/maker/blogs/2019/how-to-use-mqtt-with-the-raspberry-pi>



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Online Courses and Video Lectures:

1. Coursera: An Introduction to Programming the Internet of Things (Specialization):
<https://www.coursera.org/specializations/iot>
2. NPTEL: Introduction to Internet of Things: https://onlinecourses.nptel.ac.in/noc22_cs53/preview
3. Udemy: Internet of Things Courses: <https://www.udemy.com/topic/internet-of-things/>

Teaching -Learning– Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/ Week	No. of Weeks	Hours/ Semester
1.	Classroom Teaching & Learning	3	14	42
2.	Tutorial Component	—	—	—
3.	Activity Based Learning (ABL)	—	—	40
4.	Evaluation of Learning Process	—	—	8
Total Learning Hours / Semester				90

Proposed Assessment Plan (for 50 marks of CIE):

Tool	Remarks	Marks
CIE	Two CIEs conducted for 50 marks each and reduced to 15 marks	30
Activity Details	Activity Based Learning	20
Total		50

Activity Based Learning (40 Hours):

ABL: Analyze, design and present a neural network solution to a real-world problem		Hours
1.	Problem Identification	4
2.	Simulation of the design	30
3.	Report	5
4.	Presentation	1
Total		40

Evaluation of Learning Process (8 Hours):

Type of Evaluation	Hours
CIE (1, 2)	3
ABL Presentation and Evaluation	2
SEE	3
Total	8



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Course Articulation Matrix:

Course Outcomes	Program Outcomes											Program Specific Outcomes		
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	—	—	—	—	—	—	—	—	—	—	—	2	—
CO2	2	3	—	—	—	—	—	—	—	—	—	—	2	—
CO3	2	2	3	—	—	—	—	—	—	—	—	—	2	—
CO4	2	2	2	—	3	—	—	2	1	—	—	2	3	3



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Course Title	Fundamentals of Industrial Robots		
Course Code	25RA305	(L-T-P) C	(3 : 0 : 0) 3
Exam	3	Hours/Week	3
SEE	50 Marks	Total Hours	42 L+40ABL+8EV=90
Course Objective: To impart fundamental knowledge of industrial robots – their anatomy, configurations, kinematics, drives, end effectors, control and programming – and to enable students to analyze and apply robotic systems for real-world industrial and manufacturing applications. Course Outcomes: At the end of the course, the student will be able to:			
#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Understand the fundamental concepts, classification, specifications and applications of industrial and mobile robots along with their social and economic impact.	1, 6, 7	1
2	Analyze robot anatomy, configurations, degrees of freedom and kinematics using transformation and rotation matrices for manipulator motion.	1, 2	1
3	Analyze robot drive systems, end effectors and control types, and apply gripper force analysis for the selection of suitable actuation and gripping mechanisms.	1, 2, 3	1, 2
4	Develop robot programs using lead-through, textual and robot programming languages (VAL/ROS) for industrial applications such as pick-and-place, welding and assembly.	1, 2, 3, 5, 9, 10	1, 2
MODULE-1			11 hours
Introduction to Robotics: Introduction to robotics, robot, laws of robot, brief history of robotics, basic components of a robot, robot specifications, human system and robotics. Classification and Applications: Types of robots – manipulators; mobile robots – wheeled (classification based on wheel configurations); legged robots (classification based on number of legs); aerial robots; open kinematic vs closed kinematic chain; safety measures in robotics; social impact; robotics market and prospects; advantages and disadvantages of robots.			
MODULE-2			10 hours
Robot Anatomy and Motion Analysis: Anatomy of a robotic manipulator – links, joints, actuators, sensors, controller; robot configurations – polar, cylindrical, Cartesian, jointed-arm (Articulated and SCARA); robot links and joints; Grashoff's law; degrees of freedom (DoF) – types of movements: vertical, radial and rotational traverse, roll, pitch and yaw; work volume/envelope. Robot Kinematics: Introduction to direct and inverse kinematics; transformations and rotation matrix; numerical problems on transformation matrices – pure rotation and pure translation.			



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MODULE-3	11 hours
Robot Drives and End Effectors: Robot drive systems – hydraulic, pneumatic and electric drive systems; classification of end effectors; mechanical grippers, vacuum grippers, magnetic grippers, adhesive grippers; gripper force analysis and gripper design; 1 DoF, 2 DoF and multiple degrees of freedom robot hands; tools as end effectors. Robot Control Types: Limited sequence control, point-to-point control, playback with continuous path control, and intelligent control.	

MODULE-4	10 hours
Robot Programming: Introduction to robot programming; history of robot programming; methods of robot programming – lead-through and textual; lead-through programming methods – powered and manual lead-through; generations of robot programming languages; Assembly Language (AL), Victor's Assembly Language (VAL I), VAL II; robot language structure; introduction to Robot Operating System (ROS); syntax examples/programs on AL, VAL I and VAL II (simple programs). Applications of Robots: Industrial robots, humanoids, cobots and autonomous robots; aerial, wheeled, swarm, legged, medical/healthcare, space, service, underwater and military robots; robotics applications – pick-and-place, palletizing and depalletizing, machine loading and unloading, welding and assembly, medical, agricultural and space applications, and robotics for computer-integrated manufacturing.	

Prescribed Text Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Introduction to Robotics: Mechanics and Control	John J. Craig	3rd Edition	Pearson Education	2005
2.	Industrial Robots – Technology, Programming and Applications	Mikell P. Groover et al.	Special Indian Edition	McGraw Hill Education	2012
3.	A Gentle Introduction to ROS	Jason M. O'Kane	1st Edition	CreateSpace Independent Publishing	2013
4.	A Textbook on Industrial Robotics	Ganesh S. Hegde	3rd Edition	University Science Press	2017

Reference Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Robotics Engineering – An Integrated Approach	Richard D. Klafter, Thomas A. Chmielewski and Michael Negin	Eastern Economy Edition	Prentice Hall of India Pvt. Ltd.	2006
2.	Robotics: Control, Sensing, Vision and Intelligence	K.S. Fu, R.C. Gonzalez and C.S.G. Lee	1st Edition	McGraw Hill Education	1987

E-Books and Online Course Materials:

1. NPTEL: Introduction to Robotics (IIT Kharagpur):
https://onlinecourses.nptel.ac.in/noc22_me46/preview
2. NPTEL: Robotics and Control – Theory and Practice:
https://onlinecourses.nptel.ac.in/noc23_me102/preview



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3. ROS Documentation and Tutorials: <https://wiki.ros.org/ROS/Tutorials>
4. RoboAnalyzer – 3D Model-Based Robotics Learning Software: <https://www.roboanalyzer.com/>

Online Courses and Video Lectures:

1. NPTEL: Robotics (IIT Delhi) – Video Lectures: <https://nptel.ac.in/courses/112104287>
2. Coursera: Robotics Specialization (University of Pennsylvania):
<https://www.coursera.org/specializations/robotics>
3. The Construct: ROS Basics and Robot Programming: <https://www.theconstruct.ai/>

Teaching -Learning– Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/Semester
1.	Classroom Teaching & Learning	3	14	42
2.	Tutorial Component	–	–	–
3.	Activity Based Learning (ABL)	–	–	40
4.	Evaluation of Learning Process	–	–	8
Total Learning Hours / Semester				90

Proposed Assessment Plan (for 50 marks of CIE):

Tool	Remarks	Marks
CIE	Two CIEs conducted for 50 marks each and reduced to 15 marks	30
Activity Details	Industry-Oriented Activity Based Learning – 20 Marks	20
Total		50

Activity Based Learning (40 Hours):

Industry-Oriented Activity: Students work in small teams to study a real industrial robot deployment and reproduce a representative task in an open-source robot simulator. Each team selects an industrial application (e.g., pick-and-place, palletizing, spot/arc welding, machine tending or assembly), identifies a suitable commercial robot (ABB, KUKA, FANUC, Universal Robots, etc.) from manufacturer datasheets, models the workcell and simulates the task cycle in RoboDK / Gazebo / RViz (ROS), analyzes reach, payload, cycle time and DoF, and benchmarks the results against the manufacturer specifications. Teams document safety standards, economic justification (ROI) and present their findings, thereby gaining practical exposure to real industrial robotics practice.



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ABL: Industrial Robot Workcell Study and Simulation – model and analyze a real industrial robot application using an open-source simulator		Hours
1.	Industry survey and selection of application, robot and datasheet study	6
2.	Workcell modelling and task simulation in RoboDK / Gazebo / ROS	24
3.	Analysis, benchmarking against specifications and technical report	8
4.	Presentation and demonstration	2
Total		40

Evaluation of Learning Process (8 Hours):

Type of Evaluation	Hours
CIE (1, 2)	3
Activity Presentation and Evaluation	2
SEE	3
Total	8

Course Articulation Matrix:

Course Outcomes	Program Outcomes											Program Specific Outcomes		
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	–	–	–	–	2	1	–	–	–	–	2	–	–
CO2	3	3	–	–	–	–	–	–	–	–	–	3	–	–
CO3	3	3	2	–	–	–	–	–	–	–	–	3	2	–
CO4	3	2	2	–	3	–	–	–	2	2	–	3	3	–



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Course Title	Digital Systems for Robotics & AI Laboratory		
Course Code	25RAL307	(L-T-P) C	(0 : 0 : 2) 1
Exam	3	Hours/Week	2
SEE	50 Marks	Total Hours	28 P
Course Objective: To provide hands-on experience in interfacing sensors, actuators, displays, storage and communication peripherals with the ESP32-based Neurick platform, and to develop embedded, IoT and edge-AI applications for robotics and automation. Course Outcomes: Upon completion of the course, students shall be able to:			
#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Apply GPIO, interrupt, ADC and PWM programming concepts on the ESP32 platform to interface LEDs, push buttons, LDR sensors, servo motors and DC motors.	1, 2	2
2	Analyze and Interface digital and analog sensors such as gas, flame, ultrasonic, IR, IMU, temperature and soil moisture sensors with display, storage and cloud platforms for data acquisition and logging.	1, 2, 3, 5	2
3	Develop integrated embedded applications combining sensing, actuation and AI-based detection for automation tasks such as smart irrigation, access control and multimedia AI systems.	1–3, 5	1, 2
4	Conduct experiments in teams, record observations and document the implementation and results systematically.	8, 9, 10	2

List of Experiments (28 Hours):

#	List of Experiments
1.	Interrupt Handling with LED and Push Button Understand how hardware interrupts work and how they differ from polling techniques; implement interrupt-based button detection to control an LED with minimal CPU usage.
2.	Reading LDR Sensor Value and Printing it on the Serial Monitor and Light Automation using LDR Read analog sensor values using the ESP32 ADC and display them on the Serial Monitor; develop an automatic lighting system that switches lights based on ambient light intensity.
3.	Servo Motor and Encoder Sensor Interface with the ESP32 Control the angular position of a servo motor using PWM signals; interface an encoder to measure position or rotation and understand feedback-based motion control.
4.	DC Motor Direction and Speed Control with the Power Calculation Control the speed and direction of a DC motor using PWM and an H-Bridge motor driver; calculate electrical power consumption by measuring motor voltage and current.
5.	Reading Gas Sensor and Flame Sensor Data and Writing it to the SD Card Interface gas and flame sensors for environmental monitoring and safety applications; store timestamped sensor readings on an SD card for data logging and future analysis.



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6.	Reading Ultrasonic Sensor and IR Sensor Data and Finding the Difference in Them Understand the working principles of ultrasonic and infrared distance sensing technologies; compare sensor accuracy, range and performance under different environmental conditions.
7.	Printing the IMU MPU6050 Data on the OLED Display Interface the MPU6050 IMU using the I2C communication protocol; display real-time acceleration and gyroscope data on an OLED screen for motion visualization.
8.	Interfacing DHT22/DS18B20 Temperature Sensor and Sending Data to the Cloud Acquire temperature and humidity data from digital sensors; transmit sensor data to an IoT cloud platform for remote monitoring and data visualization.
9.	Interfacing Camera, Microphone, and Speaker with AI Detection Interface multimedia peripherals with the ESP32 for embedded AI applications; implement basic AI-based object detection and generate audio-based responses.
10.	Soil Moisture with Temperature Sensor and Pump for Agricultural Automation Monitor soil moisture and temperature for smart agriculture applications; automate water pumping based on real-time sensor readings to optimize irrigation.
11.	RFID with Servo-Based Door Lock System Understand how RFID authentication works for secure access control systems; integrate an RFID reader with a servo motor to build an automated smart door lock.

E-Books and Online Course Materials:

1. Arduino Language Reference: <https://www.arduino.cc/reference/en>
2. Arduino Project Hub: <https://create.arduino.cc/projecthub>
3. Maker Pro Raspberry Pi Tutorials: <https://maker.pro/raspberry-pi/tutorial>
4. Raspberry Pi Foundation Projects: <https://projects.raspberrypi.org/en/projects>
5. DigiKey: How to Use MQTT with the Raspberry Pi:
<https://www.digikey.com/en/maker/blogs/2019/how-to-use-mqtt-with-the-raspberry-pi>



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Teaching – Learning – Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/Semester
1.	Laboratory Sessions	2	14	28
2.	Evaluation of Learning Process	–	–	2
Total Learning Hours / Semester				30

Proposed Assessment Plan (for 50 Marks of CIE):

Tool	Remarks	Marks
Conduction	Continuous evaluation of experiment conduction, record and viva	30
Lab CIE Test	One internal laboratory test conducted for 20 marks	20
Total		50

Evaluation of Learning Process (2 Hours):

Type of Evaluation	Hours
Lab CIE Test	2
Total	2

Course Articulation Matrix:

Course Outcomes	Program Outcomes											Program Specific Outcomes	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	–	–	–	–	–	–	–	–	–	–	2
CO2	2	3	2	–	2	–	–	–	–	–	–	–	2
CO3	2	2	3	–	2	–	–	–	–	–	–	2	3
CO4	–	–	–	–	–	–	–	2	3	2	–	–	2



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Course Title	Computer Aided Modelling Lab		
Course Code	25RAL308	(L-T-P) C	(0 : 0 : 2) 1
Exam	2	Hours/Week	2
SEE	50 Marks	Total Hours	28 P

Course Objective: To provide hands-on experience in computer-aided modelling and drafting using parametric CAD tools, enabling students to create solid models, assemblies and detailed engineering drawings of machine and robotic components with industry-standard limits, fits, tolerances and GD&T.

Course Outcomes: At the end of the course, the student will be able to:

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Understand the concepts of CAD, parametric and feature-based modelling, and the CAD tool environment.	1, 5	2
2	Create solid models of machine components by applying standard sketcher and modelling features such as fillets, chamfers, holes, patterns and datum features.	1, 2, 5	1, 2
3	Develop assemblies, detailed drawings and exploded views, and apply limits, fits, tolerances and GD&T symbols as per industrial drafting standards.	1, 2, 3, 5	1, 2
4	Engage in lifelong learning by using sketching, modelling and drawing as an effective engineering communication tool and by exploring open-ended design problems in teams.	5, 8, 9, 10, 12	2

PART-A – Fixed Set of Experiments:

#	List of Experiments
1.	Introduction: Concept of parametric modelling, feature-based modelling, user interface, mouse operations, file types and management, and drawing profiles.
2.	Sketcher: Profile toolbar, operations (corner, chamfer, delimitations, transformations, project 3D element), constraints and types of constraints, workbench, sketch tools, visualization toolbar and user selection filter.
3.	Modelling: Modelling of a machined component, material addition and removal, sketch and positioned sketch, types of fillets, types of chamfers, types of hole, pattern, thread/tap, datum features, and creation of different parts using the above commands.
4.	Drafting – Detailing Drawings: Explode a 3D model for a drawing, create a drawing sheet and views, add geometry and dimensions to a drawing, add GD&T text, BOM, tables and symbols, place an exploded view, edit a title block, and export to different file formats.
5.	Assembly: (Part drawings shall be given) Modelling and assembly of any two of – Screw Jack, Plummer Block and Bench Vice.
6.	Limits, Fits and Tolerances: Introduction, fundamental tolerances, deviations, methods of placing limit dimensions, types of fits with symbols and applications, geometrical tolerances on drawings, standards followed in industry, and GD&T symbols with their usage.



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List of part drawings for assemblies: 1. Screw Jack 2. Plummer Block 3. Machine Vice 4. Connecting Rod 5. Piston Head 6. Tail Stock.

PART-B – Open-Ended Experiments:

Open-ended experiments are laboratory activities where the outcome is not predetermined and students are given the freedom to explore, design and conduct the experiment based on problem statements defined by the course coordinator. They encourage creativity, critical thinking and inquiry-based learning.

#	List of Open-Ended Experiments
1.	Modelling and assembly of any robot based on its application (e.g., robotic gripper, manipulator link, mobile robot chassis).
2.	Solving simple problems of structural analysis considering the design of robotic components.
3.	Modelling and detailing of a robotic joint / actuator mounting with appropriate tolerances and GD&T.
4.	Design and assembly of an end effector (gripper) with a force-transmission mechanism.
5.	Modelling of a gear/pulley drive train used in a robotic system and generation of its drawing.
6.	Reverse engineering – modelling of a given robotic component from a physical part or 2D sketch and preparing its production drawing.

Prescribed Text Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	A Primer on Computer Aided Machine Drawing	VTU Committee	1st	VTU, Belgaum	2007
2.	Machine Drawing	N.D. Bhatt and V.M. Panchal	42 nd	Charotar Publishing House	1999
3.	Machine Drawing	K.R. Gopalakrishna	1st	Subhas Publications	–

Reference Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	A Text Book of Computer Aided Machine Drawing	S. Trymbaka Murthy	1st	CBS Publishers, New Delhi	2007
2.	Machine Drawing	N. Siddeshwar, P. Kannaiah and V.V.S. Sastri	1st	Tata McGraw Hill	2006
3.	Machine Drawing	K.L. Narayana, P. Kannaiah and K. Venkata Reddy	3rd	New Age International	2006
4.	Machine Drawing	Ajeet Singh	2 nd	Tata McGraw Hill Education	2012



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Web Links and Video Lectures (e-Resources):

1. Autodesk: Learn Fusion 360 in 90 Minutes: <https://www.autodesk.com/certification/learn/course/learn-fusion-360-in-90-minutes>
2. Autodesk: Fusion 360 – Introduction to Modeling and Design:
<https://www.autodesk.com/certification/learn/course/fusion360-intro-modeling-design-professional>
3. NPTEL: Computer Aided Design and Manufacturing: <https://nptel.ac.in/courses/112104035>
4. GrabCAD Community Tutorials and Models: <https://grabcad.com/tutorials>

NPTEL / SWAYAM Video Lectures:

1. NPTEL/SWAYAM: Computer Aided Design (CAD) – IIT Kanpur / IIT Madras Video Lectures.
2. NPTEL/SWAYAM: Engineering Graphics and Machine Drawing Video Lectures.
3. SolidWorks / Fusion 360 / CATIA Official Essentials Tutorials – Sketcher, constraints and assembly.
4. ASME Y14.5 / ISO GPS Geometric Dimensioning and Tolerancing Quick Reference Guides.

Teaching – Learning – Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/Semester
1.	Laboratory Sessions (PART-A & PART-B)	2	14	28
2.	Evaluation of Learning Process	—	—	2
Total Learning Hours / Semester				30



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Proposed Assessment Plan (for 50 Marks of CIE):

Tool	Remarks	Marks
Lab Conduction	Continuous evaluation of experiment conduction, modelling/drawing output, record and viva (PART-A and PART-B)	30
Lab Test	One internal laboratory test conducted for 20 marks	20
Total		50

Semester End Examination (SEE) Pattern:

Semester End Examination (SEE) – Practical (50 Marks): The SEE is conducted for 100 marks and scaled down to 50 marks.

1. Students shall answer one question from PART-A and one question from PART-B.
2. The PART-A question is set from the fixed set of experiments and is evaluated for 70 marks.
3. The PART-B question is an open-ended question (not from the listed PART-A experiments) and is evaluated for 30 marks.
4. Change of experiment is allowed only once; marks are distributed between procedure/modelling and results as per the SEE rubric.

Evaluation of Learning Process (2 Hours):

Type of Evaluation	Hours
Lab Internal Test	2
Total	2

Course Articulation Matrix:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	—	—	—	2	—	—	—	—	—	—	—	—	2	—
CO2	3	2	—	—	3	—	—	—	—	—	—	—	2	3	—
CO3	3	2	2	—	3	—	—	—	—	—	—	—	2	3	—
CO4	—	—	—	—	2	—	—	2	2	2	—	2	—	2	—

Course Title	Community Project / Societal Project		
Course Code	25SCR	(L-T-P)C	(0-0-2)1
Exam	3 Hrs.	Hours/Week	2
CIE + SEE	50 marks + 50 Marks	Total Hours	30

Course Objective: Rapid urbanization, population growth, environmental concerns, energy demand, water scarcity, waste management, transportation issues and rural development challenges have created practical problems affecting communities and public welfare. This course aims to integrate technical knowledge, field exposure and societal engagement so that students identify real community issues, frame problem statements and attempt appropriate, feasible and sustainable engineering responses within the scope of a one-semester project.

Course Outcomes: At the end of the course, the student will be able to:

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Identify and analyze societal problems through field interaction and technical assessment.	1,2,3,4,6,9	-
2	Develop skills in project planning, field survey, data collection, implementation, documentation and reporting.	1,2,3,4,5,8,9,10	-
3	Formulate feasible engineering problem statements and solutions considering practical constraints and sustainability aspects.	1,2,3,5,6,7,10	-
4	Apply principles of environmental responsibility, ethics and societal welfare in engineering practice through community-oriented interventions.	6, 7	-
5	Exhibit multidisciplinary learning and problem-solving ability based on collected data, user feedback and baseline conditions.	2,3,4,5,8,9,11	-
6	Demonstrate teamwork and communication skills while interacting with technical and non-technical stakeholders and reflect on project impact on society.	6,8,9,10,11	-

Restrictions and professional conduct:

Community / Societal Projects shall remain **academic, socially responsible, technically focused, and politically neutral**. Students and faculty shall maintain professionalism, ethical conduct, public respect and institutional integrity while interacting with communities, public groups, organizations and stakeholders.

Students and faculty shall avoid the following during project execution:

- Association with political party activities, campaigns or propaganda.
- Participation in activities that may disturb communal harmony, public order or institutional reputation.
- Use of the project platform for personal, political, ideological or commercial promotion.
- Disrespectful, discriminatory or unethical interaction with community members or stakeholders.

Projects must also recognize constraints related to cost, resources, environment and safety, and stakeholder behavior/cooperation/acceptance when planning and implementing activities.

SET OF PROJECT ACTIVITIES (TW/SL = 30 HOURS)

Methods for Project Identification:

Students may identify the project topic using one or more of the following methods:

- Interaction with local rural or urban stakeholders such as local leaders, corporation/municipality personnel, NGOs, panchayat representatives, etc.
- Review of issues highlighted in print and electronic media, and social networks (WhatsApp, Facebook, X, Instagram, etc.).
- After selecting a broad topic, students shall collect data, conduct a feasibility survey, estimate timelines and resources, approximate expenditure, and then define the problem statement and objectives clearly.

List of Project Topics and Engineering Outcomes:

The following structured sequence of activities is to be carried out during the semester:

Sl.No	Project Title	Measurable Engineering Outcome	Mapped POs	SDGs
1.	Rural and urban water conservation and management systems	Prepare a site-specific water-saving plan, estimate water demand–supply gap, and propose a feasible conservation intervention with quantified savings.	PO1, PO2, PO3, PO4, PO10, PO11	SDG 6, SDG 11, SDG 12
2.	Waste management and recycling	Conduct waste audit, classify waste streams, and design a segregation/recycling workflow with measurable reduction in mixed waste.	PO2, PO3, PO4, PO6, PO8, PO10	SDG 11, SDG 12, SDG 13
3.	Afforestation	Identify a degraded area, prepare plantation layout, and demonstrate survival-rate tracking and maintenance schedule for saplings.	PO2, PO3, PO4, PO6, PO7, PO11	SDG 11, SDG 13, SDG 15
4.	Biogas generation and power generation	Estimate organic waste availability, size a small biogas system, and document expected gas output or energy yield.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 7, SDG 11, SDG 12
5.	DPR for solar power rural plant	Prepare a DPR with load assessment, panel sizing, cost estimate, and projected energy generation and payback.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 7, SDG 9, SDG 11
6.	DPR for electrification of village/tribal community	Map unserved/underserved households, propose electrification layout, and estimate coverage, losses, and implementation cost.	PO1, PO2, PO3, PO4, PO10, PO11	SDG 7, SDG 9, SDG 10

7.	DPR for rural drainage system	Survey drainage bottlenecks, develop a drainage layout, and estimate runoff handling capacity and flood-risk reduction.	PO1, PO2, PO3, PO4, PO6, PO10	SDG 6, SDG 9, SDG 11
8.	Sustainability and environmental health projects	Assess local environmental health issues and propose interventions with measurable improvement in hygiene, safety, or resource use.	PO2, PO3, PO4, PO6, PO7, PO8	SDG 3, SDG 6, SDG 11, SDG 12
9.	Plastic free campaigns	Measure plastic usage before and after awareness intervention and report percentage reduction or behavioural change.	PO2, PO3, PO6, PO7, PO8, PO10	SDG 11, SDG 12, SDG 13
10.	Health and nutrition awareness	Conduct baseline and post-program awareness survey and document improvement in awareness score or adoption of healthier practices.	PO2, PO6, PO7, PO8, PO9, PO10	SDG 2, SDG 3, SDG 11
11.	Societal projects involving health wellness	Identify a community health need and develop an awareness/service module with measurable participation and feedback outcomes.	PO2, PO3, PO6, PO8, PO9, PO10	SDG 3, SDG 11, SDG 17
12.	Air quality monitoring system	Collect air-quality data, compare with reference limits, and present trends along with possible mitigation suggestions.	PO2, PO3, PO4, PO5, PO6, PO10	SDG 3, SDG 11, SDG 13
13.	Plastic waste reduction campaign	Track collection, segregation, and replacement actions, and quantify reduction in plastic waste generation or littering.	PO2, PO3, PO6, PO7, PO8, PO10	SDG 11, SDG 12, SDG 13
14.	Urban greening projects	Prepare greening plan, identify planting locations, and assess environmental benefits such as shade, aesthetics, or heat mitigation.	PO2, PO3, PO4, PO6, PO7, PO11	SDG 11, SDG 13, SDG 15
15.	Smart agriculture solution	Design a low-cost monitoring or irrigation support solution and estimate improvement in water use efficiency or crop support.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 6, SDG 9
16.	Smart irrigation system	Estimate crop water requirement, propose control logic, and quantify water savings compared with conventional irrigation.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 6, SDG 12
17.	Youth mentoring programmes	Deliver a structured mentoring activity and measure participation, engagement, and skill/awareness improvement.	PO6, PO8, PO9, PO10, PO11	SDG 4, SDG 10, SDG 17
18.	Adult education	Conduct learner-needs assessment, prepare instructional content, and measure improvement in basic literacy or numeracy indicators.	PO6, PO8, PO9, PO10, PO11	SDG 4, SDG 10, SDG 17

19.	Food security initiatives / cold storage system	Estimate storage need, design a simple cold-chain concept, and document reduction in spoilage or wastage.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 9, SDG 12
20.	Human rights awareness with legal systems	Prepare and deliver an awareness module and assess increase in legal awareness and access-to-rights understanding.	PO6, PO7, PO8, PO9, PO10	SDG 5, SDG 10, SDG 16
21.	House tax collection through digital media	Develop a simple digital workflow or awareness support and measure improvement in compliance, convenience, or response time.	PO2, PO3, PO4, PO5, PO10, PO11	SDG 9, SDG 11, SDG 16
22.	Use of application / application program	Build or demonstrate a useful community app and measure usability, adoption, or efficiency improvement.	PO1, PO3, PO4, PO5, PO9, PO10	SDG 9, SDG 11, SDG 17
23.	Creation of Panchayat library	Plan the library model, catalogue resources, and measure usage, accessibility, or participation outcomes.	PO6, PO8, PO9, PO10, PO11 SDG 4,	SDG 10, SDG 11, SDG 17

Prescribed Text Books:

Sl.No	Book Title	Authors	Edition	Publisher
1	Community Engagement and Social Innovation	Phadke, N. D.	1st	Oxford University Press, New Delhi.
2	Project-Based Learning in Engineering Education	Garg, N. R.	1st	Pearson India Education Services, Noida.
3	Service Learning and Community Projects.	Gupta, A. and P. Singh.	1st	McGraw-Hill Education (India), New Delhi.
4	Practical Guide to Community Development Projects	Wilson, G.	2nd	Routledge, London.

Reference Books:

1. NPTEL courses on Project-Based Learning and Social Innovation.
2. SWAYAM courses on community engagement and sustainability.
3. UN Sustainable Development Goals portal: <https://sdgs.un.org>
4. MyGov India and local civic body portals for community initiatives.
5. YouTube resources on design thinking, social innovation, and community service learning.
6. NGO and government field-action case studies related to sanitation, water, health, education, and environment.

Web links and Video Lectures (e-Resources):

1. NPTEL courses on Engineering Geology (IIT Roorkee, IIT Kharagpur).
2. NPTEL courses on Soil Mechanics and Foundation Engineering (IIT Delhi, IIT Bombay).
3. Virtual Labs – Geotechnical Engineering Virtual Lab (IIT Kanpur): <https://vlab.co.in>
4. Geological Survey of India (GSI) – Maps, reports, and publications: <https://www.gsi.gov.in>
5. YouTube channels: Civil Engineering Essentials, The Engineering Classroom (soil mechanics experiments).
6. American Society of Civil Engineers (ASCE) – Geotechnical resources and standards

Teaching-Learning Process:

Week / Phase	Teaching-Learning Activity	Faculty Role	Student Activity	Output / Evidence
1	Course introduction, objectives, ethics, conduct, and assessment briefing	Explain course scope, rules, rubrics, and expected deliverables	Understand course requirements and form teams	Team list, course plan
2	Community problem identification and topic selection	Guide topic framing and feasibility	Identify local issues through discussion and observation	Shortlisted project topic
3	Stakeholder interaction and preliminary survey	Demonstrate survey methods and stakeholder engagement	Collect initial data from community/users	Survey notes, interview record
4	Problem statement and objective formulation	Review and refine problem statement	Prepare problem statement, scope, and objectives	Approved problem statement
5	Literature/case study review and baseline analysis	Suggest relevant references and examples	Study existing solutions and compare approaches	Baseline analysis summary
6	Project planning and role assignment	Help teams organize tasks, timeline, and responsibilities	Plan activities, divide roles, and prepare schedule	Work plan / Gantt chart

7	Feasibility analysis and solution brainstorming	Check technical feasibility and practicality	Generate possible engineering solutions	Solution alternatives sheet
8	Selection of final solution and design approach	Review final concept and design logic	Finalize concept, methods, and expected outcome	Concept note / design outline
9	Data processing / calculations / sizing / mapping	Support computations and technical review	Analyze data, perform calculations, prepare maps/charts	Technical analysis sheet
10	Prototype / model / audit / DPR / app development	Monitor progress and correct technical issues	Develop the selected output	Working model / draft DPR / map / app
11	Testing, refinement, and implementation planning	Evaluate technical correctness and improvements	Test prototype or validate proposal with users	Test results / revised output
12	Field implementation / demonstration / awareness activity	Facilitate community interaction and documentation	Conduct implementation or demonstration	Photos, attendance, implementation record
13	Documentation of outcomes, feedback, and impact	Review report structure and completeness	Compile findings, stakeholder feedback, and observations	Draft report
14	Presentation preparation and viva practice	Conduct mock presentation and feedback	Prepare slides/poster and rehearse	Presentation deck
15	Final presentation, submission, and reflection	Evaluate performance using rubrics	Present project, submit report, reflect on learning	Final report, presentation, viva

Assessment structure:

A. Continuous Internal Evaluation (CIE) – 50 marks

- Students, in batches of 3–4, shall undertake at least one project (or a combination of two related activities) aiming, as far as possible, at a logical implemented or implementable outcome.
- CIE will be conducted by a departmental committee (HoD/nominee, guide and one senior faculty) using the following rubrics totaling 50 marks:

B. Semester End Examination (SEE) – 50 marks

- The SEE shall be conducted batch-wise by a committee of : one faculty from the same department and one from a different department.

CIE and SEE Rubrics

Criterion	Weight (marks)	Excellent (Full marks)	Good	Fair	Needs Improvement
Problem identification & Relevance to society/industry/community	8	Problem is clearly identified with strong evidence of societal relevance and well-defined scope.	Problem is relevant and scope is clear with adequate supporting evidence.	Problem defined but justification or evidence is weak.	Problem unclear or not relevant; little/no supporting evidence.
Formation of problem statement; Engineering approach, innovation & feasibility	10	Problem statement is precise; approach is sound, innovative and clearly feasible.	Problem statement adequate; approach feasible with minor gaps.	Problem statement partial; approach feasibility is marginal.	Problem statement missing or approach not feasible.
Interaction with stakeholders; Data collection, analysis & interpretation	8	Thorough stakeholder engagement; data collection is comprehensive; analysis is well-interpreted.	Good engagement; data analysis adequate with minor gaps.	Limited engagement; data incomplete and analysis superficial.	Little/no stakeholder contact; insufficient or no data/analysis.
Project documentation; Clarity, organization & problem-solving demonstrated	10	Documentation is complete, well-organized, analytical, and shows strong problem-solving.	Documentation complete and clear with some analytical content.	Documentation on basic with omissions; problem-solving limited.	Documentation missing/poorly organized; no clear problem-solving.
Communication & Presentation skills	6	Presentation is confident, structured, and answers queries fully; visuals effective.	Presentation clear and satisfactory; responds to most queries.	Presentation acceptable but lacks clarity or confidence; weak responses	Presentation poor or absent; unable to respond.

Contribution & Benefit to society (impact, sustainability)	8	Clear, demonstrable societal benefit and sustainability; realistic path to implementation.	Benefit plausible; sustainability considered with minor gaps.	Limited or unclear societal benefit; sustainability not well addressed.	No evident benefit or sustainability; project not community-oriented.
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[illegible]

Semester: III						
PHYSICAL EDUCATION (SPORTS & ATHLETICS)–I						
Course Code	:	25PE1		CIE	:	100 Marks
Credits: L:T:P	:	0:0:1				
Total Hours	:	15 P				
Course Outcomes: At the end of the course, the student will be able to 1. Understand the fundamental concepts and skills of Physical Education, Health, Nutrition and Fitness 2. Familiarization of health-related Exercises, Sports for overall growth and development 3. Create a foundation for the professionals in Physical Education and Sports 4. Participate in the competition at regional/state/national/international levels. 5. Create consciousness among the students on Health, Fitness and Wellness in developing and maintaining a healthy lifestyle. 6. Understand and practice of Traditional Games						
Module I: Orientation A. Lifestyle B. Health & Wellness C. Pre-Fitness test.						4 Hours
Module II: General Fitness & Components of Fitness A. Warming up (Free Hand exercises) B. Strength–Push-up/Pull-ups C. Speed– 30Mtr Dash						4 Hours
Module III: Specific games (Any one to be selected by the student) 1. Kabaddi–Handtouch, Toe Touch, Thigh Hold, Anklehold and Bonus. 2. Kho-Kho– Giving Kho, Single Chain, Pole dive, Pole turning, 3-6 Up.						16 Hours

Scheme and Assessment for auditing the course and Grades:

Sl.No.	Activity	Marks
1.	Participation of student in all the modules	20
2.	Quizzes/Assignment–2, each of 20 marks	40
3.	Final presentation/exhibition/Participation In competitions/practical on specific tasks assigned to the students	40
Total		100

Semester III			
Yoga - I			
Course Code	25YOG1	CIE	100 Marks
Course Type	NCMC		
Total Hours	2 hrs/week		
Course Objectives The objectives of this course are to: 1. Introduce students to the origin, history, philosophy, and fundamental concepts of Yoga. 2. Familiarize students with the different schools of Yoga, its aims, objectives, and the importance of prayer in Yogic practice. 3. Develop awareness of the rules, regulations, and safety precautions to be followed during Yogic practices. 4. Enable students to learn and practice Suryanamaskara and selected Yogasanas with proper techniques for improving physical and mental well-being. 5. Promote a healthy life style by encouraging regular Yogic practice, correcting misconceptions about Yoga, and fostering positive health, self-discipline, and overall wellness.			
Introduction of Yoga: Yoga, its origin, history and development. Yoga, its meaning, definitions. Different schools of yoga, Aim and Objectives of yoga, Prayer : importance of prayer Brief introduction of yogic practices for common man to promote positive health, Rules and regulations: Rules to be followed during yogic practices by practitioner Suryanamaskara: Suryanamaskar prayer and its meaning, Need, importance and benefits of Suryanamaskar 12 count, 2 rounds, Misconceptions of yoga: Yoga its misconceptions , Difference between yogic and non yogic practices Different types of Asanas: Asana, Need, importance of Asana. Different types of asana. Asana its meaning by name, technique, precautionary measures and benefits of each asana, Sitting 1. Padmasana, 2. Vajrasana, Standing 1. Vrikshana, 2. Trikonasana, Prone 1. Bhujangasana, 2. Shalabhasana, Supine 1. Utthitadvipadasana, 2. Ardhamahalasana			
Course Outcomes: Upon successful completion of this course, the student will be able to: 1. Explain the origin, history, philosophy, objectives, and different schools of Yoga, along with its role in promoting holistic health and well-being. 2. Understand and apply the rules, regulations, and ethical practices associated with Yogic exercises, including the significance of prayer and Suryanamaskara. 3. Demonstrate the correct techniques of selected Yogasanas, such as sitting, standing, prone, and supine postures, while observing appropriate precautions. 4. Analyze the physical, mental, and therapeutic benefits of Yogic practices and distinguish between authentic Yogic practices and common misconceptions about Yoga. 5. Adopt Yoga as a regular life style practice to enhance physical fitness, mental wellness, discipline, and overall quality of life.			

Suggested Learning Resources: (TextBook/ReferenceBook/Manuals):**Text books:**

1. George Feuerstein: the yoga Tradition (its history, literature, philosophy and practice)
2. Sri Ananda: The complete Book of yoga Harmony of Body and Mind (Orient paper Backs: Vision Books Pvt.Ltd..1982.
3. B.K.Slyenkar: Light on the Yoga sutras of Patanjali (Haper Collins Publications India Pvt.Ltd.New Delhi.)
4. Science of Divinity and Realization of Self Vethathiri Publication,(6-11)WCSC,Erode

Reference books/Manuals:

1. Principles and Practice of Yoga in Health Care,Publisher:Handspring Publishing Limited. ISBN:9781909141209,978190914209
2. BasavaraddiIV: Yoga in School Health, MDNIY NewDelhi. 2009
3. Dr.HR.Nagendra: Yoga Research and application (Vivekanda Kendra Yoga Prakashana Bangalore)
4. Dr.Shirley Telles: Glimpses of Human Body (Vivekanda KendraYoga Prakashana Bangalore).

Web links and Video Lectures (e-Resources):

Search by topics to get the videos

Assessment Structure:

This course is having only **Continuous Internal Assessment** (CIE) marks of 100.

Weightage	Marks
Attendance to all the sessions	20Marks
Practical sessions on Yoga and Its Benefits	40Marks
Two Assignments	40Marks
Total Marks	100

A student shall obtain a minimum of 40% marks or 40 marks out of 100 to qualify in the course.



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Course Title	Bridge Mathematics-I (Mandate Audit Course for Diploma entry students)		
Course Code	25BCM301	L-T-P	(3-0-0)
Exam	3 Hrs.	Hours/Week	3
CIE	50 Marks	Total Hours	42
Course Objective: Students will be able to use appropriate data structures for solving problems.			
Course Outcomes: At the end of course, student will be able to:			
#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Solve simple problems on determinants, matrix multiplication, partial differentiation, and integration.	1	-
2	Compute the roots of transcendental equations and interpolate when the experimental data is given.	1	-
3	Expand the given function in terms of Taylor/ Macluarin's series	1	-
MODULE-1			10 Hrs.
Basic Formulas: Partial fractions. Matrices and determinants: matrix multiplication, evaluation of determinants, finding inverse. Differentiation-I: Review of limit and Continuity, differentiation- Basic formulas, Sum rule, product rule, quotient rule, chain rule and problems. Differentiation-II: Taylor's series, and Macluarin's series of simple functions for single variable, simple problems.			
MODULE-2			10 Hrs.
Partial Differentiation: Definition, Illustrative examples on Partial differentiation, Total differentiation, chain rule, Differentiation of composite and implicit functions, Jacobians, illustrative examples and problems, simple problems.			
MODULE-3			10 Hrs.
Integration: Basic formulas, Illustrative examples, evaluation of definite integrals, Integration by parts, Bernoulli's rule of Integration. Integral calculus: Reduction formula for functions $\sin^n x$, (without proof), Simple problems, Double & triple integration, simple problems with standard limits.			
MODULE-4			12 Hrs.
Numerical Methods - Numerical Solution of algeBRac & transcendental equations by Bisection method, Newton Raphson method, Regular Falsi method. Numerical Interpolation -Definition of forward, backward differences, Newton's forward and backward interpolation formulae, Lagrange's interpolation formula.			



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Prescribed Text Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
01	Higher Engineering Mathematics	Dr.B.S.Grewal	40 th edition	Khanna Publications	2007
02	Advanced Engineering Mathematics	Erwin Kreyszig	8 th edition	TataMcGrawHill, Publications	2007

Reference Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
01	Calculus	Thomas Finney	9 th edition	Pearson education	2002
02	A text book of Engineering Mathematics	N.P. Baliand Manish Goyal	Reprint	Laxmi Publications	2010

Teaching - Learning - Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/ Week	No. of Weeks	Hours/ Semester
1	Class Room Teaching & Learning	3	12	36
2	Integrated Lab Component	0	0	00
3	Student Study Hours - Self Learning	2	1	2
3	Activity Based Learning (ABL1 & ABL2)	-	-	-
4	Evaluation of Learning Process	-	-	04
Total Learning Hours/Semester				42

Proposed Assessment Plan(for 50marks of CIE):

Tool	Remarks	Marks
CIE	Two CIEs conducted for 50 marks each and reduced to 50 marks	50
Total		50

Evaluation of Learning Process (4 Hours)

Type of Evaluation	Hours
CIE (1 and 2)	4
Lab component	0
Semester End Exam	0
Total	4



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4th Semester



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Course Title	Robot Kinematics and Dynamics																						
Course Code	24RA401	(L-T-P) C	(3 : 0 : 0)3																				
Exam	3 Hours	Hours/Week	3																				
SEE	50 Marks	Total Hours	42 L+40ABL+8EV=90																				
Course Objective: To provide a strong analytical foundation in the kinematics, differential motion, dynamics and trajectory planning of robotic manipulators, enabling students to model, analyze and simulate serial robots for motion control and industrial applications. Course Outcomes: At the end of the course, the student will be able to: <table> <tr> <th>#</th><th>Course Outcomes</th><th>Mapping to PO's</th><th>Mapping to PSO's</th></tr> <tr> <td>1</td><td>Apply 3D homogeneous transformations and Denavit–Hartenberg notation to formulate the forward kinematic model of serial manipulators such as 2R, 3R, cylindrical and SCARA robots.</td><td>1, 2</td><td>1</td></tr> <tr> <td>2</td><td>Analyze the inverse kinematics of manipulators to obtain closed-form joint solutions and examine the existence, multiplicity and solvability of solutions.</td><td>1, 2</td><td>1</td></tr> <tr> <td>3</td><td>Analyze the differential motion and statics of manipulators using the Jacobian to determine link velocities and identify singular configurations.</td><td>1, 2, 3</td><td>1</td></tr> <tr> <td>4</td><td>Develop dynamic models and trajectory plans for robotic manipulators using the Lagrange–Euler formulation and joint-space/Cartesian-space planning techniques.</td><td>1, 2, 3, 5, 9</td><td>1, 2</td></tr> </table>				#	Course Outcomes	Mapping to PO's	Mapping to PSO's	1	Apply 3D homogeneous transformations and Denavit–Hartenberg notation to formulate the forward kinematic model of serial manipulators such as 2R, 3R, cylindrical and SCARA robots.	1, 2	1	2	Analyze the inverse kinematics of manipulators to obtain closed-form joint solutions and examine the existence, multiplicity and solvability of solutions.	1, 2	1	3	Analyze the differential motion and statics of manipulators using the Jacobian to determine link velocities and identify singular configurations.	1, 2, 3	1	4	Develop dynamic models and trajectory plans for robotic manipulators using the Lagrange–Euler formulation and joint-space/Cartesian-space planning techniques.	1, 2, 3, 5, 9	1, 2
#	Course Outcomes	Mapping to PO's	Mapping to PSO's																				
1	Apply 3D homogeneous transformations and Denavit–Hartenberg notation to formulate the forward kinematic model of serial manipulators such as 2R, 3R, cylindrical and SCARA robots.	1, 2	1																				
2	Analyze the inverse kinematics of manipulators to obtain closed-form joint solutions and examine the existence, multiplicity and solvability of solutions.	1, 2	1																				
3	Analyze the differential motion and statics of manipulators using the Jacobian to determine link velocities and identify singular configurations.	1, 2, 3	1																				
4	Develop dynamic models and trajectory plans for robotic manipulators using the Lagrange–Euler formulation and joint-space/Cartesian-space planning techniques.	1, 2, 3, 5, 9	1, 2																				
MODULE-1			11 Hours																				
Forward Kinematics: Introduction to forward and inverse kinematics; 3D homogeneous transformations and their applications to robot kinematics; links, joints and their parameters; kinematic modelling of the manipulator; Denavit–Hartenberg notation; kinematic relationship between adjacent links; direct kinematics solution for 2R planar manipulator, 3R robot, cylindrical robot, SCARA robot and RPY wrist.																							
MODULE-2			10 Hours																				
Inverse Kinematics: Manipulator workspace; solvability of the inverse kinematic model; existence of solution; multiple solutions; solution technique; closed-form solution; guidelines to obtain closed-form solutions; inverse kinematic solution for 2R planar manipulator, 3-DOF articulated arm robot, cylindrical robot, RPY wrist and SCARA robot.																							
MODULE-3			10 Hours																				
Manipulator Differential Motion and Statics: Linear and angular velocity of a link; linear velocity due to angular motion; combined linear and angular motion; relationship between transformation matrix and angular velocity; mapping velocity vector; velocity propagation of a link; manipulator Jacobian; Jacobian computation; prismatic and rotary joint Jacobian; Jacobian inverse; Jacobian singularity; computation of singularities; wrist singularities and singular configurations; determination of Jacobian matrix and singular configurations for 2R and 3R robots.																							



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MODULE-4	11 Hours
Robot Dynamics: Lagrangian mechanics; two-degree-of-freedom manipulator dynamic model; Lagrange–Euler formulation; velocity of a point on the manipulator; the inertia tensor; the kinetic energy; the potential energy; equation of motion; the LE dynamic model algorithm; derivation of dynamic equation of motion for a 2-DOF robot configuration. Robot Trajectory Planning: Definitions and planning tasks; terminology; joint-space techniques; use of a p-degree polynomial as interpolation function; cubic polynomial trajectories; linear function with parabolic blends; Cartesian-space techniques; straight-line path; circular path; position planning; orientation planning; joint-space versus Cartesian-space trajectory planning; 4-3-4 joint trajectory planning; problems.	

Prescribed Text Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Robotics and Control	R.K. Mittal and I.J. Nagrath	1st Edition	McGraw Hill Education	2003
2.	Robotics: Control, Sensing, Vision and Intelligence	K.S. Fu, R.C. Gonzalez and C.S.G. Lee	1st Edition	McGraw Hill Education	2008
3.	Introduction to Robotics: Analysis, Control, Applications	Saeed B. Niku	2nd Edition	Pearson Education	2008

Reference Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Introduction to Robotics: Mechanics and Control	John J. Craig	2nd Edition	Addison-Wesley	1989
2.	Fundamentals of Robotics: Analysis and Control	Robert J. Schilling	1st Edition	Prentice Hall of India (PHI)	2006
3.	Robot Modeling and Control	Mark W. Spong, Seth Hutchinson and M. Vidyasagar	1st Edition	John Wiley & Sons	2005
4.	Robot Dynamics and Control	Mark W. Spong and M. Vidyasagar	1st Edition	John Wiley & Sons	2004

E-Books and Online Course Materials:

- NPTEL: Robotics (Mechanics and Control of Robotic Manipulators): https://onlinecourses.nptel.ac.in/noc20_me53/preview
- SWAYAM: Mechanics and Control of Robotic Manipulators: <https://www.classcentral.com/course/swayam-mechanics-and-control-of-robotic-manipulators-43637>



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3. IIT Kharagpur Virtual Labs – Mechatronics and Robotics: <http://vlabs.iitkgp.ac.in/mr/>
 4. RoboAnalyzer – 3D Model-Based Robotics Learning Software: <https://www.roboanalyzer.com/>

Online Courses and Video Lectures:

1. NPTEL: Introduction to Robotics (IIT Delhi / IIT Kanpur) – Video Lectures.
 2. Coursera: Modern Robotics – Mechanics, Planning and Control (Northwestern University):
<https://www.coursera.org/specializations/modernrobotics>
 3. MIT OpenCourseWare: Introduction to Robotics: <https://ocw.mit.edu/>

Teaching – Learning – Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/Semester
1.	Classroom Teaching & Learning	3	14	42
2.	Tutorial Component	–	–	–
3.	Activity Based Learning (ABL)	–	–	40
4.	Evaluation of Learning Process	–	–	8
Total Learning Hours / Semester				90

Proposed Assessment Plan (for 50 Marks of CIE):

Tool	Remarks	Marks
CIE	Two CIEs conducted for 50 marks each and reduced to 15 marks	30
Activity Details	Activity Based Learning – 20 Marks	20
Total		50

Activity Based Learning (40 Hours):

Activity: Students work in teams to model, analyze and simulate the kinematics and dynamics of a selected serial manipulator (2R, 3R, SCARA or articulated arm) using an open-source tool such as RoboAnalyzer, MATLAB Robotics Toolbox (Peter Corke) or ROS MoveIt. Each team derives the D-H parameters, computes the forward and inverse kinematics, evaluates the Jacobian and singularities, and plans a joint-space/Cartesian trajectory, validating the analytical results against the simulation.

ABL: Kinematic and Dynamic Modelling and Simulation of a Serial Manipulator using an open-source robotics tool		Hours
1.	Selection of manipulator and derivation of D-H parameters	6
2.	Modelling, kinematic/dynamic analysis and simulation using the tool	24
3.	Validation, results and technical report	8
4.	Presentation	2
Total		40



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Evaluation of Learning Process (8 Hours):

Type of Evaluation	Hours
CIE (1, 2)	3
Activity Presentation and Evaluation	2
SEE	3
Total	8

Course Articulation Matrix:

Course Outcomes	Program Outcomes											Program Specific Outcomes		
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	–	–	–	–	–	–	–	–	–	3	–	–
CO2	3	3	–	–	–	–	–	–	–	–	–	3	–	–
CO3	3	3	2	–	–	–	–	–	–	–	–	3	–	–
CO4	3	3	2	–	3	–	–	–	2	–	–	3	2	–



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Course Title	Object Oriented Programming		
Course Code	25RA402	(L-T-P) C	(3:0:2)4
Exam	3	Hours/Week	5
SEE	50 Marks	Total Hours	42L + 28P+40ABL+8EV=120

Course Objective: To impart the fundamentals of the object-oriented programming paradigm using C++, enabling students to design and develop robust, reusable and efficient programs using classes, inheritance, polymorphism, the standard template library, exception handling, file I/O and templates for engineering and robotics applications.

Course Outcomes:

At the end of the course, the student will be able to:

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Apply the fundamental concepts of the object-oriented paradigm, tokens, control structures and functions to develop C++ programs for engineering problems.	1, 2, 5	1, 2
2	Develop C++ programs using classes, objects, constructors, destructors and encapsulation, and use standard library containers such as strings, vectors and associative containers.	1, 2, 3, 5	1, 2
3	Apply operator overloading, inheritance and polymorphism to design reusable and extensible object-oriented solutions.	1, 2, 3, 5	1, 2
4	Develop robust C++ applications using exception handling, file I/O, templates and generic programming, and document the implementation and results.	1-3, 5, 8, 9, 10	1, 2

MODULE-1	11 Hours
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Principles of Object-Oriented Programming: Object-oriented programming paradigm; basic concepts of object-oriented programming; applications of object-oriented programming.

Beginning with C++: What is C++; applications of C++; a simple C++ program; structure of a C++ program; creating the source file; compiling and linking.

Tokens, Expressions and Control Structures: Tokens; keywords; identifiers and constants; basic data types; user-defined and derived data types; declaration of variables; reference variables; operators in C++; expressions and their types; operator precedence; control structures.

Functions in C++: Function prototyping; call by reference; return by reference; inline functions; default arguments; const arguments; function overloading.



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MODULE-2	11 Hours
Classes and Objects: C structure revisited; specifying a class; defining member functions; a C++ program with class; making an outside function inline; nesting of member functions; private member functions; arrays within a class; memory allocation for objects; static data members and member functions; arrays of objects; objects as function arguments; friendly functions; returning objects; const member functions. Constructors and Destructors: Constructors; parameterized constructors; multiple constructors in a class; constructors with default arguments; dynamic initialization of objects; copy constructor; const objects; destructors. Standard Library Containers: Strings, vectors and arrays – library string type, library vector type, introducing iterators, arrays; sequential containers – overview and operations (adding, accessing, erasing elements, resizing, container adaptors); associative containers – overview and operations.	
MODULE-3	10 Hours
Operator Overloading and Type Conversions: Defining operator overloading; overloading unary operators; overloading binary operators; overloading binary operators using friend functions; rules for overloading operators; type conversions. Inheritance: Defining derived classes; single inheritance; making a private member inheritable; multilevel, multiple, hierarchical and hybrid inheritance; virtual base classes; abstract classes; constructors in derived classes. Pointers, Virtual Functions and Polymorphism: Pointers; pointers to objects; this pointer; pointers to derived classes; virtual functions; pure virtual functions.	
MODULE-4	10 Hours
Basic Exception Handling: try blocks and exception handling; throwing and catching exceptions. Enumerations: Defining and using enumerations. File Input and Output: The I/O classes; file input and output; string streams. Templates and Generic Programming: Defining a template; function and class templates; template argument deduction; introduction to generic algorithms.	

Prescribed Text Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Object-Oriented Programming with C++	E. Balagurusamy	8th Edition	McGraw Hill Education	2021
2.	C++ Primer	Stanley B. Lippman, Josée Lajoie and Barbara E. Moo	5th Edition	Addison-Wesley / Pearson	2012



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Reference Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Object-Oriented Programming in C++	Robert Lafore	4th Edition	Sams Publishing / Pearson	2002
2.	Programming: Principles and Practice Using C++	Bjarne Stroustrup	2nd Edition	Addison-Wesley	2014

E-Books and Online Course Materials:

1. cppreference – C++ Reference (language features, STL containers, algorithms, I/O and exceptions): <https://en.cppreference.com/>
2. LearnCpp – Modern C++ Tutorials (classes, constructors, inheritance, polymorphism, templates and STL): <https://www.learncpp.com/>
3. ROS 2 Documentation – C++ Publisher and Subscriber Tutorials (C++ in robotic software architecture): <https://docs.ros.org/>
4. GeeksforGeeks – C++ STL and OOP Practice Resources: <https://www.geeksforgeeks.org/c-plus-plus/>

Online Courses and Video Lectures:

1. NPTEL / SWAYAM – Programming in C++ / Object-Oriented Programming: <https://onlinecourses.nptel.ac.in/>
2. NPTEL – Programming in Modern C++ (IIT Kharagpur): <https://nptel.ac.in/courses/106105151>

Teaching – Learning – Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/Semester
1.	Classroom Teaching & Learning	3	14	42
2.	Integrated Lab Component	2	14	28
3.	Tutorial Component	–	–	–
4.	Activity Based Learning (ABL)	–	–	42
5.	Evaluation of Learning Process	–	–	8
Total Learning Hours / Semester				120



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Proposed Assessment Plan (for 50 Marks of CIE):

Tool	Remarks	Marks
CIE	Two CIEs conducted for 50 marks each and reduced to 15 marks	30
Activity Details	1. Lab Component – 10 Marks (Record – 5 Marks, Lab CIE – 5 Marks) 2. Project Based Learning – 10 Marks	20
Total		50

Integrated Lab Component (28 Hours):

#	List of Experiments
1.	Develop a C++ program to calculate basic robot motion parameters such as distance, speed and time. Demonstrate function prototyping, call by reference, inline functions, default arguments and function overloading.
2.	Develop a C++ program to create a Robot class with data members such as robot ID, robot name, robot type, payload capacity and battery level. Use member functions to read and display robot details.
3.	Design a Sensor class with sensor ID, sensor type, measurement unit and current reading. Use default, parameterized and copy constructors to initialize and display sensor details.
4.	Implement a Motor class with speed, torque and direction as private data members. Use public member functions to set and display motor values, validate unsafe values (negative or over-limit speed), and use a friend function to compare the torque of two motors.
5.	Develop a C++ program to store and display details of multiple sensors using an array of objects (sensor ID, sensor type and current reading), and identify the sensor with the highest reading.
6.	Design a MobileRobot class using composition by including objects of the Battery and Motor classes. Display the complete status of the mobile robot including battery percentage and motor speed.
7.	Develop a C++ program to store sensor names and readings using string and vector. Use iterators to display the stored sensor details and compute the average sensor reading.
8.	Develop a C++ program to manage robot tasks using standard library containers – use a queue to store pending robot tasks and a map to store each robot ID with its current status.
9.	Create a RobotPose class with x-position and y-position. Overload the + operator to update the robot position and overload a comparison operator to compare two robot positions.
10.	Implement inheritance using a base class Sensor and derived classes such as UltrasonicSensor and TemperatureSensor. Demonstrate how derived classes reuse and extend the base class features.
11.	Create a base class Actuator with a virtual function operate(). Derive classes such as ServoMotor and Gripper and override the function to display actuator-specific operation (runtime polymorphism).
12.	Develop a C++ program to read and write robot configuration data to a file using file I/O, and demonstrate basic exception handling and a class template for storing generic sensor data.



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Activity Based Learning (42 Hours):

Project Based Learning: Students work in small teams to design and build a mini C++ application relevant to robotics/automation (e.g., a robot fleet manager, a sensor-data logger and analyzer, an inventory/task scheduler, or a simple simulation of robot motion). The project must demonstrate classes and objects, constructors/destructors, inheritance, polymorphism, operator overloading, STL containers, exception handling, file I/O and templates. Teams design the class hierarchy, implement and test the code, document it, and present a demonstration.

ABL: Object-Oriented Mini-Project in C++ for a robotics/automation application		Hours
1.	Problem identification and class/object design	6
2.	Implementation, testing and debugging	28
3.	Documentation and report	6
4.	Presentation and demonstration	2
Total		42

Evaluation of Learning Process (8 Hours):

Type of Evaluation	Hours
CIE (1, 2)	3
Lab / Activity Presentation and Evaluation	2
SEE	3
Total	8

Course Articulation Matrix:

Course Outcomes	Program Outcomes											Program Specific Outcomes		
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	—	—	2	—	—	—	—	—	—	2	2	—
CO2	3	2	2	—	2	—	—	—	—	—	—	2	3	—
CO3	3	3	2	—	2	—	—	—	—	—	—	2	3	—
CO4	3	3	2	—	3	—	—	2	2	2	—	2	3	—



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Course Title	CONTROL SYSTEMS		
Course Code	25RA403	(L-T-P) C	(3:0:0)3
Exam	3 Hours	Hours/Week	3
SEE	50 Marks	Total Hours	42L +40ABL+8EV=90

Course Objective: To provide a strong foundation in the modelling, analysis and design of linear control systems, enabling students to represent physical systems mathematically, analyze their time- and frequency-domain behaviour, assess stability, and apply state-space methods to mechatronic and robotic systems.

Course Outcomes:

At the end of the course, the student will be able to:

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Explain the basic concepts, components and classification of open-loop and closed-loop control systems and the effect of feedback.	1, 2	1
2	Develop mathematical models and transfer functions of mechanical, electrical, thermal and hydraulic systems, and reduce block diagrams and signal flow graphs using Mason's gain formula.	1, 2	1
3	Analyze the time-domain response, time-response specifications and steady-state error of first- and second-order systems.	1, 2	1
4	Analyze the stability of control systems using the Routh-Hurwitz criterion, root locus and frequency-domain (Bode/Nyquist) methods, and represent systems using the state-space approach.	1, 2, 5	1, 2

MODULE-1	11 Hours
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Introduction to Control Systems: Definition of a control system; need for and importance of control systems; examples of control systems in mechanical engineering – liquid level, temperature and speed control systems; basic components of a control system; block diagram of a control system – input, output, controller, plant, actuator, sensor and feedback element.

Types and Components of Control Systems: Open-loop and closed-loop control systems; comparison between open-loop and closed-loop systems; advantages and disadvantages of feedback; common sensors and actuators used in industrial control systems; use of relays, switches and contactors; brief introduction to logic-based and sequential control systems.

MODULE-2	11 Hours
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Mathematical Modelling of Systems: Need for mathematical modelling; differential equation models of simple systems; mechanical systems – translational and rotational systems, mass-spring-damper system; electrical systems – R, L and C elements, simple RLC circuit; basic thermal and hydraulic systems; transfer function concept; poles and zeros of a transfer function.

Block Diagram and Signal Flow Graph: Open-loop and closed-loop transfer functions; rules of block diagram algebra; simple block diagram reduction; signal flow graph; basic terms in a signal flow graph; Mason's gain formula; simple problems.



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MODULE-3	10 Hours
Time Response of Systems: Introduction to time-domain analysis; standard test signals – step, ramp and impulse; first-order and second-order system response; transient and steady-state response; time-response specifications – rise time, peak time, maximum overshoot and settling time. Steady-State Error and Effect of Feedback: Steady-state error; type of system; position, velocity and acceleration error constants; steady-state error for step, ramp and parabolic inputs; sensitivity and effect of parameter variations; effect of feedback on stability, accuracy and disturbance rejection; simple numerical problems.	
MODULE-4	10 Hours
Stability Analysis: Meaning of stability; stable, unstable and marginally stable systems; effect of pole location on stability; Routh–Hurwitz stability criterion; construction of the Routh array; simple problems on the Routh–Hurwitz criterion; root locus technique, construction rules and effect of gain variation; stability analysis using root locus. Frequency-Domain Analysis: Introduction and need for frequency-domain analysis; Bode plot basics – magnitude and phase plots; gain margin and phase margin; frequency-domain specifications; introduction to the Nyquist stability criterion (conceptual treatment only, no numerical problems); correlation between time-domain and frequency-domain response. State-Space Approach: Need for state-space representation in modern control systems; state variables and state equations; simple state-space models of mechanical and electromechanical systems; introduction to bond graphs; eigenvalues, state transition matrix, controllability and observability; introduction to state feedback control and applications in servo systems, DC motors and mechatronic systems.	

Prescribed Text Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Modern Control Engineering	Katsuhiko Ogata	5th Edition	Pearson Education, New Delhi	2010
2.	Control Systems Engineering	Norman S. Nise	8th Edition	Wiley India Pvt. Ltd., New Delhi	2020
3.	Automatic Control Systems	Benjamin C. Kuo and Farid Golnaraghi	10th Edition	Wiley India Pvt. Ltd., New Delhi	2017

Reference Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Control Systems Engineering	I.J. Nagrath and M. Gopal	7th Edition	New Age International Publishers, New Delhi	2021
2.	Feedback Control of Dynamic Systems	Gene F. Franklin, J. David Powell and Abbas Emami-Naeini	8th Edition	Pearson Education, New Delhi	2019



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3.	Modern Control Systems	Richard C. Dorf and Robert H. Bishop	13th Edition	Pearson Education, New Delhi	2017
4.	Control Systems	A. Anand Kumar	2nd Edition	PHI Learning Pvt. Ltd., New Delhi	2014
5.	Control Systems: Principles and Design	M. Gopal	5th Edition	McGraw Hill Education (India) Pvt. Ltd., New Delhi	2021

E-Books and Online Course Materials:

1. NPTEL: Control Systems (IIT Madras) – complete syllabus coverage: <https://nptel.ac.in/courses/108106098>
2. SWAYAM / NPTEL: Control Systems (12-week course): https://onlinecourses.nptel.ac.in/e-learning/preview/noc20_ee90
3. MATLAB Control System Toolbox Tutorials: <https://www.mathworks.com/products/control.html>
4. Control Tutorials for MATLAB and Simulink – Root Locus: <https://ctms.engin.umich.edu/CTMS/index.php?example=Introduction§ion=ControlRootLocus>
5. Control Tutorials for MATLAB and Simulink – Suspension System Example: <https://ctms.engin.umich.edu/CTMS/index.php?example=Suspension§ion=ControlRootLocus>

Online Courses and Video Lectures:

1. NPTEL: Control Engineering (IIT Kharagpur) – Video Lectures: <https://nptel.ac.in/courses/108105159>
2. MIT OpenCourseWare: Feedback Control Systems: <https://ocw.mit.edu/>

Teaching – Learning – Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/Semester
1.	Classroom Teaching & Learning	3	14	42
2.	Tutorial Component	–	–	–
3.	Activity Based Learning (ABL)	–	–	40
4.	Evaluation of Learning Process	–	–	8
Total Learning Hours / Semester				90

Proposed Assessment Plan (for 50 Marks of CIE):

Tool	Remarks	Marks
CIE	Two CIEs conducted for 50 marks each and reduced to 15 marks	30
Activity Details	Activity Based Learning – 20 Marks	20
Total		50



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Course Title	Sensors and Actuators		
Course Code	25RA404	(L-T-P) C	(3:0:0)3
Exam	3 Hours	Hours/Week	3
SEE	50 Marks	Total Hours	42L +40ABL+8EV=90

Course Objective: To provide knowledge of measurement systems, sensors and transducers, signal conditioning and actuators, enabling students to select, analyze and integrate appropriate sensing and actuation elements and control circuits for robotic, mechatronic and automation systems.

Course Outcomes:

At the end of the course, the student will be able to:

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Understand the principles of measurement systems, their static and dynamic characteristics, errors and fluid power systems.	1, 2	1
2	Apply appropriate sensors and transducers for the measurement of physical quantities such as temperature, flow, pressure, displacement, force and torque in engineering and robotic systems.	1, 2, 3	1, 2
3	Analyze signal conditioning and digital signal processing techniques for the pre-processing of sensor signals.	1, 2	1
4	Analyze pneumatic, hydraulic and electrical actuators and Design fluid-power and electro-pneumatic control circuits for automation applications.	1, 2, 3, 5	1, 2

MODULE-1

10 Hours

Measurements and Measuring Systems: Methods of measurement; instruments; classification of instruments; functions of instruments and measurement systems; elements of a generalized measurement system. Measurement system performance – static and dynamic characteristics. Errors in measurement and their statistical analysis.

Fluid Power System: Basic components, advantages, limitations and applications; transmission of power at static and dynamic states; Pascal's law.

MODULE-2

11 Hours

Sensors / Transducers: Definition, types, basic principle and applications. Potentiometers; inductance transducers; capacitance transducers; piezoelectric transducers; Hall-effect transducers; rotary encoders; accelerometers; gyroscope; photodiode/phototransistor as sensors; LVDT; strain gauge; tactile, IR and ultrasonic sensors; vision and motion sensors. Digital transducers – principle and construction. Measurement of temperature, flow, velocity, pressure, displacement, position, force and torque.

MODULE-3

11 Hours

Signal Conditioning: Need for pre-processing; identification of signal conditioning blocks and their characteristics; analysis of DC and AC bridges; offset and drift compensation circuits; introduction to active filters – first-order, second-order and higher-order filters; necessity and applications of isolation amplifiers; grounding and shielding.

Digital Signal Processing: Discrete sequences and systems; periodic sampling; Discrete Fourier Transform;



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Fast Fourier Transform; analog-to-digital conversion.

Pneumatic and Hydraulic Actuators: Linear actuator types – single-acting and double-acting cylinders; rotary actuator types – gear, vane, screw and piston types; symbols for pneumatic, hydraulic and electro-pneumatic systems.

MODULE-4

10 Hours

Electrical Actuators: Introduction to electrical actuators; solenoids; rotating electrical machines – operating principles, main terminology and industrial standards; DC, synchronous, induction, stepper, BLDC and servo motors – principle of operation, main characteristics, construction, types, starting, speed control and braking, efficiency, testing and selection considerations.

Circuit Design: Control of single- and double-acting hydraulic cylinders; hydraulic cylinder sequencing circuits; speed control of hydraulic cylinders – meter-in, meter-out and bleed-off circuits. Pneumatic and electro-pneumatic circuit design – direct and indirect actuation of pneumatic cylinders; speed control by supply-air and exhaust-air throttling; electro-pneumatic control – signal input and output, pilot-assisted solenoid control of DCVs, use of relays and contactors.

Prescribed Text Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Measurement Systems: Application and Design	E.O. Doebelin and D.N. Manik	7th Edition	McGraw Hill	2019
2.	Understanding Digital Signal Processing	Richard G. Lyons	3rd Edition	Pearson	2011
3.	A Course in Electronic Measurements and Instrumentation	A.K. Sawhney	–	Dhanpat Rai & Co. (P) Ltd.	2015
4.	Pneumatics and Hydraulics	Andrew Parr	–	Jaico Publishing House	1993

Reference Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Transducers and Instrumentation	D.V.S. Murthy	2nd Edition	Prentice Hall of India	2011
2.	A First Course on Electric Drives	S.K. Pillai	–	Wiley Eastern Limited, Bombay	2012
3.	Electric Machinery Fundamentals	Stephen J. Chapman	4th Edition	McGraw Hill Education Pvt. Ltd.	2010
4.	Hydraulics and Pneumatics	Jagadeesha T	1st Edition	I.K. International Publishing House, New Delhi	2015



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E-Books and Online Course Materials:

1. NPTEL: Sensors and Actuators (IIT Kharagpur): https://onlinecourses.nptel.ac.in/noc22_ee11/preview
2. NPTEL: Industrial Automation and Control: <https://nptel.ac.in/courses/108105088>
3. NPTEL: Hydraulics and Pneumatics: <https://nptel.ac.in/courses/112106175>
4. All About Circuits – Sensors and Signal Conditioning: <https://www.allaboutcircuits.com/textbook/>

Online Courses and Video Lectures:

1. NPTEL: Sensors and Actuators – Video Lectures: <https://nptel.ac.in/courses/108108147>
2. NPTEL/SWAYAM: Digital Signal Processing: https://onlinecourses.nptel.ac.in/noc21_ee36/preview
3. Festo Didactic – Pneumatics and Electro-Pneumatics Learning Resources: <https://www.festo-didactic.com/>

Teaching – Learning – Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/Semester
1.	Classroom Teaching & Learning	3	14	42
2.	Tutorial Component	–	–	–
3.	Activity Based Learning (ABL)	–	–	40
4.	Evaluation of Learning Process	–	–	8
Total Learning Hours / Semester				90

Proposed Assessment Plan (for 50 Marks of CIE):

Tool	Remarks	Marks
CIE	Two CIEs conducted for 50 marks each and reduced to 15 marks	30
Activity Details	Activity Based Learning – 20 Marks	20
Total		50

Activity Based Learning (40 Hours):

Activity: Students work in teams to design, build and characterize a small sensor-and-actuator based system relevant to robotics/automation (e.g., an obstacle-avoiding module using ultrasonic/IR sensors, a temperature- or level-controlled actuator, a strain/force-measurement setup, or a pneumatic pick-and-place cell). Each team selects appropriate sensors and actuators, implements the signal conditioning and control, calibrates the system, analyzes its static/dynamic characteristics and errors, and documents and presents the results.



Evaluation of Learning Process (8 Hours):

Course Articulation Matrix:

Course Outcomes	Program Outcomes											Program Specific Outcomes		
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	–	–	–	–	–	–	–	–	–	2	–	–
CO2	3	3	2	–	–	–	–	–	–	–	–	2	2	–
CO3	3	3	–	–	–	–	–	–	–	–	–	2	–	–
CO4	3	3	2	–	2	–	–	–	–	–	–	2	2	–



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Course Title	Design of Robotic components		
Course Code	25RA405	(L-T-P) C	(2:2:0)3
Exam	3 Hours	Hours/Week	4
SEE	50 Marks	Total Hours	28L+28T+26ABL+8EV=90

Course Objective: To impart the fundamentals of machine design and enable students to design robotic and mechanical components – shafts, keys, fasteners, belts, gears and bearings – for static, impact and fatigue loading using standard design codes and data handbooks.

Course Outcomes:

At the end of the course, the student will be able to:

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Apply the design process, theories of failure and the concept of stress concentration to design machine and robotic components for static strength.	1, 2, 3	1, 2
2	Design shafts subjected to impact and fatigue loading based on strength and rigidity using ASME and BIS codes.	1, 2, 3	1, 2
3	Design keys, threaded fasteners and belt drives for power transmission in robotic and mechanical systems.	1, 2, 3	1, 2
4	Design gear drives, sliding-contact bearings and select antifriction bearings for robotic power-transmission and support applications.	1, 2, 3, 5	1, 2

MODULE-1

10 Hours

Introduction – Design Process: Definition of design; phases of design; review of engineering materials and their properties and manufacturing processes; use of codes and standards; selection of preferred sizes.

Design for Static Strength: Factor of safety and service factor; failure mode – definition and types; failure of brittle and ductile materials, even and uneven materials; theories of failure – maximum normal stress theory, maximum shear stress theory, distortion energy theory and strain energy theory.

Stress Concentration: Stress concentration, stress concentration factor and methods of reducing stress concentration.

MODULE-2

11 Hours

Impact Strength: Introduction; impact stresses due to axial, bending and torsion loads.

Fatigue Loading: Introduction to fatigue failure; mechanism of fatigue failure; types of fatigue loading; S-N diagram; low-cycle and high-cycle fatigue; endurance limit.

Design of Shafts: Torsion of shafts; solid and hollow shaft design with steady loading based on strength and rigidity; ASME and BIS codes for power transmission shafting.

MODULE-3

10 Hours

Design of Keys: Types of keys and their applications; design considerations in parallel and tapered sunk keys; design of square and rectangular sunk keys.

Threaded Fasteners: Types of screw fastening; forms of threads; stresses in threaded fasteners; initial stresses due to screwing-up forces; stresses due to external forces; stresses due to combined forces.

Belts: Materials of construction of flat and V belts; power rating of belts; concept of slip and creep; initial



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tension; effect of centrifugal tension; maximum power condition; selection of flat and V belts (length and cross-section) from manufacturers' catalogues; construction and application of timing belts.

MODULE-4

11 Hours

Gear Drives: Classification of gears; materials for gears; standard systems of gear tooth; lubrication of gears; gear tooth failure modes. Spur gears – definitions; stresses in gear tooth: Lewis equation and form factor; design for strength; dynamic load and wear.

Lubrication and Bearings: Lubricants and their properties; bearing materials and properties; mechanisms of lubrication; hydrodynamic lubrication; pressure development in oil film; bearing modulus; coefficient of friction; minimum oil film thickness; heat generated and heat dissipated; numerical examples on hydrodynamic journal and thrust bearing design.

Antifriction Bearings: Types of rolling contact bearings and their applications; static and dynamic load carrying capacities; equivalent bearing load; load-life relationship; selection of bearings subjected to cyclic loads and speeds; probability of survival.

Note: Use of design data handbooks is permitted in CIE and SEE. Design equations, charts and standard tables shall be referred from approved design data handbooks.

Prescribed Text Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Shigley's Mechanical Engineering Design	Richard G. Budynas and J. Keith Nisbett	10th Edition	McGraw-Hill Education	2015
2.	Design of Machine Elements	V.B. Bhandari	4th Edition	Tata McGraw Hill	2017
3.	Design of Machine Elements – II	M.H. Annaiah	1st Edition	New Age International (P) Ltd.	2013

Reference Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Machine Design – An Integrated Approach	Robert L. Norton	2nd Edition	Pearson Education	2005
2.	Design of Machine Elements	M.F. Spotts and T.E. Shoup	8th Edition	Pearson Education	2006
3.	Machine Design (Schaum's Outline Series)	Hall, Holowenko and Laughlin (Adapted by S.K. Somani)	Special Indian Edition	Tata McGraw Hill Publishing Company Ltd.	2008



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4.	Design Data Handbook	K. Mahadevan and K. Balaveera Reddy	4th Edition	CBS Publishers & Distributors	2013
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E-Books and Online Course Materials:

1. NPTEL: Design of Machine Elements (IIT Kharagpur): <https://nptel.ac.in/courses/112105125>
2. NPTEL: Machine Design (IIT Bombay): <https://nptel.ac.in/courses/112101305>
3. NPTEL: Rolling Element Bearings – Design and Analysis: <https://nptel.ac.in/courses/112103297>
4. MITCalc / Engineering Toolbox – Machine Design References: <https://www.engineeringtoolbox.com/>

Online Courses and Video Lectures:

1. NPTEL: Design of Machine Elements I & II – Video Lectures: <https://nptel.ac.in/courses/112105124>
2. NPTEL/SWAYAM: Fundamentals of Machine Design: https://onlinecourses.nptel.ac.in/noc22_me11/preview

Teaching – Learning – Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/Semester
1.	Classroom Teaching & Learning	2	14	28
2.	Tutorial Component	2	14	28
3.	Activity Based Learning (ABL)	–	–	26
4.	Evaluation of Learning Process	–	–	8
Total Learning Hours / Semester				90

Proposed Assessment Plan (for 50 Marks of CIE):

Tool	Remarks	Marks
CIE	Two CIEs conducted for 50 marks each and reduced to 15 marks	30
Activity Details	1. Tutorial / Design Problem Sheets – 10 Marks 2. Activity Based Learning (Design Project) – 10 Marks	20
Total		50

Activity Based Learning (26 Hours):

Activity: Students work in teams to carry out the complete design of a robotic power-transmission or structural sub-assembly (e.g., a robot joint shaft with keys and bearings, a gearbox for a robotic actuator, or a belt/gear drive for a mobile robot). Each team selects materials, applies the appropriate theory of failure, designs the shaft/keys/fasteners/gears/bearings using design data handbooks and codes, prepares design calculations and a drawing, and presents the design with justification.



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Course Title	Sensors and Actuators Laboratory		
Course Code	25RAL406	(L-T-P) C	(0 : 0 : 2) 1
Exam	2 Hours	Hours/Week	2
SEE	50 Marks	Total Hours	28 P

Course Objective: To provide hands-on experience in the study, interfacing and characterization of sensors, signal conditioning circuits and hydraulic/pneumatic actuation systems, and in the implementation of digital signal processing on embedded platforms for robotic and automation applications.

Tools and Platforms (Open Source / Hardware): The ESP32-based Neurick embedded kit is used for sensor interfacing, data acquisition and digital signal processing experiments (with the Arduino IDE and Python/SciPy). Analog signal-conditioning experiments (active filters and bridges) are conducted on an analog electronics bench. Hydraulic and pneumatic circuits are pre-simulated in Festo FluidSIM before being built and analyzed on a fluid-power trainer.

Course Outcomes:

At the end of the course, the student will be able to:

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Analyze the performance and characteristics of inertial, vision-based and proximity sensors for engineering applications.	1, 2, 5	1, 2
2	Design, construct and evaluate signal conditioning circuits including data converters, active filters and bridges.	1, 2, 3, 5	1, 2
3	Build and analyze fluid power circuits for the controlled actuation and sequencing of hydraulic and pneumatic systems.	1, 2, 3, 5	1, 2
4	Formulate and implement digital signal processing techniques through open-ended experimentation on embedded platforms, and document and present the results.	1-3, 5, 8, 9, 10	1, 2

PART-A – Fixed Set of Experiments:

#	List of Experiments
1.	Study of accelerometer, gyroscope and vision-based sensing. Platform: (BNO055 IMU + OV3660 camera). Interface the IMU over I2C to read acceleration and angular rate, display the data on the OLED, and capture an image using the on-board camera.
2.	Ultrasonic, IR and Hall-effect sensor-based proximity and range sensing. Platform: (expansion sensors). Interface ultrasonic, IR and Hall-effect sensors, read proximity/range values on the Serial Monitor and compare their range and accuracy.
3.	Analog-to-digital and digital-to-analog conversion. Platform: (ESP32 ADC/DAC). Acquire an analog signal through the ESP32 ADC, reconstruct it through the DAC and observe quantization and resolution effects.



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4.	Experimentation with active filters. Platform: Analog electronics bench (op-amp based). Build first- and second-order active low-pass/high-pass filters and plot their frequency response; optionally pre-simulate in an open-source SPICE tool (e.g., LTspice / ngspice).
5.	Construction and analysis of a hydraulic circuit for actuation and control of single- and double-acting cylinders. Platform: Fluid-power (hydraulic) trainer. Pre-simulate the circuit in Festo FluidSIM, then build and analyze the actuation and control of single- and double-acting cylinders.
6.	Construction and analysis of a pneumatic circuit for actuation and control of single- and double-acting cylinders. Platform: Fluid-power (pneumatic) trainer. Pre-simulate the circuit in Festo FluidSIM, then build and analyze the actuation and control of single- and double-acting cylinders.

PART-B – Open-Ended Experiments:

Open-ended experiments are laboratory activities where the outcome is not predetermined and students are given the freedom to explore, design and conduct the experiment based on problem statements defined by the course coordinator. They encourage creativity, critical thinking and inquiry-based learning.

#	List of Open-Ended Experiments
1.	Experimentation with AC and DC bridges using discrete components. Platform: Analog electronics bench. Build AC and DC bridge circuits using discrete components, balance the bridge and measure the unknown parameter.
2.	Implementation of convolution and digital filters. Platform: (ESP32) / Raspberry Pi with Python (NumPy/SciPy). Acquire an analog signal through an ADC and implement convolution and digital (FIR/IIR) filtering on the sampled data.
3.	Fourier transforms. Platform: (ESP32) / Raspberry Pi with Python (NumPy/SciPy). Acquire an analog signal through an ADC and compute its Discrete/Fast Fourier Transform to obtain the frequency spectrum.
4.	Construction and analysis of a hydraulic circuit for sequencing of two hydraulic cylinders using sequence valves. Platform: Hydraulic trainer + Festo FluidSIM. Pre-simulate and then build a two-cylinder sequencing circuit using sequence valves and verify the sequence of operations.
5.	Construction and analysis of a pneumatic circuit for sequencing of two pneumatic cylinders using sequence valves. Platform: Pneumatic trainer + Festo FluidSIM. Pre-simulate and then build a two-cylinder sequencing circuit using sequence valves and verify the sequence of operations.
6.	Construction and analysis of a pneumatic circuit for controlled actuation and control of single- and double-acting cylinders. Platform: Pneumatic trainer + Festo FluidSIM. Design and analyze an electro-pneumatic circuit for controlled actuation using directional control valves, relays and solenoids.



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Reference Books / Manuals:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering	W. Bolton	–	Pearson Education	–
2.	Introduction to Mechatronics and Measurement Systems	David G. Alciatore	–	McGraw-Hill	–
3.	Fluid Power with Applications	Anthony Esposito	–	Pearson Education	–
4.	Design with Operational Amplifiers and Analog Integrated Circuits	Sergio Franco	–	McGraw-Hill	–
5.	Digital Signal Processing: Principles, Algorithms and Applications	John G. Proakis and Dimitris G. Manolakis	–	Pearson	–
6.	Raspberry Pi Cookbook: Software and Hardware Problems and Solutions	Simon Monk	–	O'Reilly Media	–

Web Links and Video Lectures (e-Resources):

1. Festo FluidSIM / Automation Studio – simulation of hydraulic, pneumatic and electro-pneumatic sequencing and throttling circuits: <https://www.festo-didactic.com/>
2. ESP32 Arduino Core Documentation – ADC, DAC, I2C and sensor interfacing: <https://docs.espressif.com/projects/arduino-esp32/en/latest/>
3. Python SciPy Signal Processing – convolution, digital filters and FFT: <https://docs.scipy.org/doc/scipy/reference/signal.html>
4. NPTEL/SWAYAM: Sensors and Actuators / Industrial Instrumentation (IIT Kharagpur / IIT Bombay) – active filters, encoders, IMUs and signal-conditioning bridges: <https://nptel.ac.in/courses/108108147>
5. NPTEL: Fluid Power Control – ISO fluid schematics, directional control valves and sequence valves: <https://nptel.ac.in/courses/112106175>
6. Virtual Labs (V-Lab) India – Electronics & Communications: active filters, ADC/DAC and bridge experiments: <https://www.vlab.co.in/>

Teaching – Learning – Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/Semester
1.	Laboratory Sessions (PART-A & PART-B)	2	14	28
2.	Evaluation of Learning Process	–	–	2
Total Learning Hours / Semester				30



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Proposed Assessment Plan (for 50 Marks of CIE):

Tool	Remarks	Marks
Lab Conduction	Continuous evaluation of experiment conduction, record and viva across PART-A and PART-B, scaled to 30 marks	30
Lab Test	One internal laboratory test (03 hours) conducted for 50 marks and scaled down to 20 marks	20
Total		50

Semester End Examination (SEE) Pattern:

Semester End Examination (SEE) – Practical (50 Marks): The SEE is conducted for 100 marks and scaled down to 50 marks.

1. Students shall answer one question from PART-A and one question from PART-B.
2. The PART-A question is set from the fixed set of experiments and is evaluated for 70 marks.
3. The PART-B question is an open-ended question (not from the listed PART-A experiments) and is evaluated for 30 marks.
4. Marks are distributed between procedure/conduction, results and viva as per the SEE rubric.

Evaluation of Learning Process (2 Hours):

Type of Evaluation	Hours
Lab Internal Test	2
Total	2

Course Articulation Matrix:

Course Outcomes	Program Outcomes											Program Specific Outcomes		
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	—	—	2	—	—	—	—	—	—	2	2	—
CO2	3	3	2	—	2	—	—	—	—	—	—	2	2	—
CO3	3	3	2	—	2	—	—	—	—	—	—	2	2	—
CO4	3	2	2	—	3	—	—	2	2	2	—	2	3	—



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Course Title	Industrial Robot Laboratory		
Course Code	25RAL407	(L-T-P) C	(0 : 0 : 2) 1
Exam	2 hours	Hours/Week	2
SEE	50 marks	Total Hours	28 P

Course Objective: To provide hands-on experience in the kinematic analysis, coordinate transformation, trajectory planning, programming and simulation of industrial robots using open-source tools (Webots and RoboAnalyzer), enabling students to evaluate manipulator performance and develop robotic automation routines for industrial and vision-integrated applications.

Software Tools (Open Source): Webots (Cyberbotics, Apache 2.0) is used as the primary industrial-robot simulation platform for PART-A, using its built-in industrial manipulator models (ABB IRB, KUKA, Universal Robots UR5e/UR10e, Franka Panda) with controllers written in Python. RoboAnalyzer is used for the PART-B kinematics, Jacobian and singularity experiments, optionally supported by Peter Corke's Robotics Toolbox for Python.

Course Outcomes:

At the end of the course, the student will be able to:

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Evaluate the kinematic performance parameters and coordinate transformations of industrial manipulators.	1, 2, 5	1, 2
2	Formulate and solve direct and inverse kinematic equations, including Jacobian and singularity analyses, for standard robot configurations.	1, 2, 3, 5	1, 2
3	Synthesize and simulate smooth trajectory profiles for robotic manipulator paths.	1, 2, 3, 5	1, 2
4	Design and program robotic automation routines for complex industrial tasks and vision-integrated operations, and document and present the results.	1-3, 5, 8, 9, 10	1, 2

PART-A – Fixed Set of Experiments:

#	List of Experiments
1.	Determination of the maximum and minimum position of links (work envelope). Tool: Webots (UR5e / ABB IRB model). Jog each joint through its limits using a Python supervisor controller, record end-effector positions and plot the reachable work envelope.
2.	Verification of transformation (position and orientation) with respect to the gripper and world coordinate systems. Tool: Webots. Read the tool-centre-point (TCP) pose relative to the world and base frames using the supervisor API, and verify the position and orientation transformation between frames.
3.	Estimation of accuracy, repeatability and resolution. Tool: Webots. Command the manipulator to approach a target point repeatedly and record the deviations to estimate accuracy, repeatability and resolution.



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4.	Robot programming and simulation for pick-and-place. Tool: Webots (UR5e / Franka Panda with gripper). Program a pick-and-place cycle using a Python controller with the built-in inverse-kinematics solver and demonstrate the complete task cycle.
5.	Robot programming and simulation for colour identification. Tool: Webots (Camera + Recognition node). Use the on-board camera to identify objects by colour and program the robot to sort them accordingly.
6.	Robot programming and simulation for shape identification. Tool: Webots (Camera + OpenCV). Acquire the camera image, identify objects by shape and program the robot to handle them based on the detected shape.
7.	Robot programming and simulation for machining (cutting, welding). Tool: Webots (ABB IRB / KUKA model). Program a continuous tool path (welding seam or cutting path) and simulate the machining operation along the path.
8.	Robot programming and simulation for any industrial process (packaging, assembly). Tool: Webots. Model a simple industrial workcell (conveyor + manipulator) and program a packaging or assembly sequence.

PART-B – Open-Ended Experiments:

Open-ended experiments are laboratory activities where the outcome is not predetermined and students are given the freedom to explore, design and conduct the experiment based on problem statements defined by the course coordinator. They encourage creativity, critical thinking and inquiry-based learning.

#	List of Open-Ended Experiments
1.	Experiments on direct kinematics of 3R, SCARA and RPY robots. Tool: RoboAnalyzer. Define the D-H parameters and compute and visualize the forward kinematics for 3R, SCARA and RPY configurations; optionally verify using Peter Corke's Robotics Toolbox for Python.
2.	Experiments on inverse kinematics of 3R, SCARA and RPY robots. Tool: RoboAnalyzer. Solve the inverse kinematics for a given end-effector pose, examine multiple solutions and animate the resulting motion.
3.	Experiments on linear and rotary joint Jacobian. Tool: RoboAnalyzer / Robotics Toolbox. Compute the Jacobian relating joint rates to end-effector linear and angular velocities and interpret the velocity mapping.
4.	Experiments on estimation of the Jacobian for (a) 2R robot and (b) 3R robot. Tool: RoboAnalyzer / Robotics Toolbox. Derive and evaluate the Jacobian matrix for 2R and 3R manipulators at various configurations.
5.	Experiments on robot singularities for (a) 2R robot and (b) 3R robot. Tool: RoboAnalyzer / Robotics Toolbox. Identify singular configurations from the determinant of the Jacobian and visualize the loss of degrees of freedom.



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6.	Experiments on simulation of a polynomial trajectory. Tool: RoboAnalyzer (or Webots). Generate and simulate a cubic / 4-3-4 polynomial joint trajectory and plot the position, velocity and acceleration profiles.
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Prescribed Text Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Introduction to Robotics: Mechanics and Control	John J. Craig	3rd Edition	Pearson Education	2005

Reference Books / Manuals:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Industrial Robotics: Technology, Programming and Applications	Mikell P. Groover, Mitchell Weiss, Roger N. Nagel and Nicholas G. Odrey	2nd Edition	McGraw-Hill	2012
2.	Robotics, Vision and Control: Fundamental Algorithms in Python	Peter Corke	3rd Edition	Springer	2023
3.	Webots Reference Manual and User Guide	Cyberbotics Ltd.	—	Cyberbotics (Open Source)	—
4.	Virtual Labs (VLab) India – Mechanism and Robotics Lab	Ministry of Education, Govt. of India (hosted by IITs)	—	Virtual Labs, MoE	—

Web Links and Video Lectures (e-Resources):

1. Webots Open-Source Robot Simulator (Cyberbotics) – documentation, industrial robot models and Python controller tutorials: <https://cyberbotics.com/doc/guide/index>
2. RoboAnalyzer – 3D model-based robotics learning software for D-H parameters, forward/inverse kinematics, Jacobian and trajectory: <https://www.roboanalyzer.com/>
3. Peter Corke’s Robotics Toolbox for Python (open source) – kinematics, Jacobian and trajectory programming: <https://petercorke.github.io/robotics-toolbox-python/>
4. NPTEL/SWAYAM: Robotics / Industrial Automation (IIT Delhi / IIT Guwahati) – coordinate transformations, work-envelope calculations, precision and repeatability: <https://nptel.ac.in/courses/112104287>
5. NPTEL: Robot Kinematics and Dynamics – joint Jacobians, velocity mapping and singularity avoidance: <https://nptel.ac.in/courses/112101099>



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6. MHRD Virtual Labs – Robotics and Spatial Kinematics (forward/inverse kinematics and workspace profiles):
<https://vlab.co.in/broad-area-mechanical-engineering>

Teaching – Learning – Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/Semester
1.	Laboratory Sessions (PART-A & PART-B)	2	14	28
2.	Evaluation of Learning Process	–	–	2
Total Learning Hours / Semester				30

Proposed Assessment Plan (for 50 Marks of CIE):

Tool	Remarks	Marks
Lab Conduction	Continuous evaluation of experiment conduction, record and viva across PART-A and PART-B, scaled to 30 marks	30
Lab Test	One internal laboratory test (03 hours) conducted for 50 marks and scaled down to 20 marks	20
Total		50

Semester End Examination (SEE) Pattern:

Semester End Examination (SEE) – Practical (50 Marks): The SEE is conducted for 100 marks and scaled down to 50 marks.

1. Students shall answer one question from PART-A and one question from PART-B.
2. The PART-A question is set from the fixed set of experiments and is evaluated for 70 marks.
3. The PART-B question is an open-ended question (not from the listed PART-A experiments) and is evaluated for 30 marks.
4. Marks are distributed between procedure/conduction, results and viva as per the SEE rubric.

Evaluation of Learning Process (2 Hours):

Type of Evaluation	Hours
Lab Internal Test	2
Total	2



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Course Articulation Matrix:

Course Outcomes	Program Outcomes											Program Specific Outcomes		
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	–	–	2	–	–	–	–	–	–	2	2	–
CO2	3	3	2	–	2	–	–	–	–	–	–	2	2	–
CO3	3	3	2	–	2	–	–	–	–	–	–	2	2	–
CO4	3	2	2	–	3	–	–	2	2	2	–	2	3	–



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Course Title		BIOLOGY FOR ENGINEERS			
Course Code	25RA408	(L-T-P)C	(0-2-0)1		
Exam	3 Hrs.	Hours/Week	2		
SEE	50 Marks	Total Hours	28		
Course Objective: Realization of relation between Natural Engineering and man-made Engineering.					
Course outcomes: At the end of course, student will be able to:					
#	Course Outcomes		Mapping to PO's	Mapping to PSO's	
1.	To familiarize engineering students with basic biological concepts		1	-	
2.	To involve students in an interdisciplinary vision of biology and engineering		2	-	
3.	To gain an appreciation for how biological systems can be designed and engineered to substitute natural system		2	-	
4.	To develop biological models using AI tools		3	-	
MODULE – 1				6 Hrs.	
Introduction to Human Anatomy: Overview of human anatomy, Structural organization of the human body- cardiovascular system, endocrine system, digestive system, respiratory system, excretory system, lymphatic system, nervous system, muscular system and skeletal system.					
MODULE – 2				8 Hrs.	
Bioinspired Engineering based on human physiology: Circulatory system (artificial heart, pacemaker, stents), Nervous system (Artificial neural network).					
MODULE -3				8 Hrs.	
Bioinspired Algorithms and Applications: Genetic algorithm, Gene expression modelling. Parallel Genetic Programming: Methodology, History, and Application to Real-Life Problems. Dynamic Updating DNA Computing Algorithms. Beehive: New Ideas for Developing Routing Algorithms Inspired by Honey Bee Behaviour.					
MODULE -4				6 Hrs.	
Artificial Intelligence and Biology: Applications of AI in medical imaging, neural engineering, systems biology, microbiome and data mining.					
Text Books:					
Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Bioinspired Engineering	Jenkins, C.H., NY	1 st	Momentum press	2012
2.	A Practical Guide to Bio- inspired Design	Hashemi Farzaneh, Helena, Lindemann, Udo	1 st	Springer	2019
Proposed Assessment Plan (for 50 marks of CIE):					
Tool		Remarks			Marks
CIE	CIE1				
	CIE2				
	CIE3				
Activity Details					

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ENVIRONMENTAL SCIENCE PROJECT			
Course Code	25EVS	CIE Marks	50
Course Type	PROJ	SEE Marks	50
Teaching Hours/Week (L:T:P:S)	0:0:2:0	Total Marks	100
Total Hours of Pedagogy	26 hours	Exam Hours	3
Credits	01	Semester	IV

Course Objectives:

1. To develop students awareness, understanding, and responsibility toward the environment.
2. To study real-world environmental issues through field surveys, case studies, and environmental audits.
3. To apply scientific and engineering principles to design feasible and sustainable solutions to environmental problems.
4. To analyze environmental data and propose remedial or preventive measures for improving biodiversity, air quality, and thermal comfort.

About the Course:

The Environmental Science Project is an applied learning component designed to develop students' awareness, understanding, and responsibility toward the environment. It provides an opportunity to study real-world environmental issues and apply scientific and engineering principles to design feasible and sustainable solutions.

The topics under environment include, but are not limited to, climate change, biodiversity, air and water pollution, land use, excess use of natural resources, earthquakes, rise in the earth's temperature, power generation, soil erosion, and environment-related programmes.

The project involves problem identification, field surveys, case studies, data collection, environmental audits, analysis, and proposal of remedial or preventive measures aimed at improving biodiversity, air quality, and thermal comfort.

Students can take up projects individually or in a group not exceeding 4 students. Students can opt for an interdisciplinary project based on their interest.

Guidelines for Conducting the Environmental Science Project:

1. Students may undertake the project individually or in a group of not more than 4 members, and may opt for an interdisciplinary project based on interest.
2. Each student/group shall identify a genuine environmental issue in consultation with the faculty guide.
3. A faculty member shall be allotted as a guide/mentor to monitor the progress of the project.
4. The project shall involve problem identification, field surveys, data collection, environmental audits, analysis, and the proposal of remedial or preventive measures.
5. Students shall maintain a project log/diary recording weekly progress, field visits, sampling / measurement data, and observations.
6. The project work shall be documented as a report and presented before an evaluation committee.
7. Wherever applicable, students should collaborate with Pollution Control Boards, forest/environment departments, local bodies, NGOs, or research institutions.
8. Ethical conduct, safety during field/lab work, and adherence to environmental regulations must be maintained throughout the project.



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Suggested Project Domains (Indicative, not exhaustive):

Climate Change: Carbon footprint estimation, greenhouse gas monitoring, climate adaptation/mitigation studies.

- Biodiversity: Flora/fauna surveys, habitat assessment, green-cover mapping, conservation initiatives.
- Air Quality: Ambient air monitoring, AQI analysis, indoor air-quality assessment, emission reduction measures.
- Water Resources: Water-quality testing, rainwater harvesting, wastewater treatment, water conservation.
- Land and Soil: Soil erosion assessment, land-use change studies, solid-waste management.
- Energy and Resources: Renewable power generation, energy audits, sustainable use of natural resources.
- Thermal Comfort & Urban Environment: Urban heat-island studies, green building/landscaping, microclimate improvement.

Course Outcomes (COs):

On completion of this course, students will be able to:

CO	Course Outcome Statement
CO1	Identify and analyze a real-world environmental problem through field surveys, case studies, and environmental audits.
CO2	Collect and analyze environmental data using appropriate scientific and engineering methods.
CO3	Design and propose feasible, sustainable remedial or preventive solutions to the identified environmental issue.
CO4	Document and communicate the project outcomes through reports and presentations, demonstrating environmental responsibility and ethics.

CO–PO / PSO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	2	3	3	2	2	2	-	2	2	2
CO2	3	3	2	3	3	2	2	2	3	2	-	2	3	2
CO3	3	3	3	2	2	3	3	2	3	2	2	2	3	3
CO4	-	2	2	-	2	3	2	3	3	3	2	3	2	2

Note: 1 – Low, 2 – Medium, 3 – High level of correlation; '-' indicates no correlation.

Continuous Internal Evaluation (CIE):

The Environmental Science Project carries 50 CIE marks. The Semester End Examination (SEE) carries 50 SEE marks. The CIE shall be evaluated continuously by the project guide and a departmental evaluation committee based on the following components:



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Evaluation Component	Marks
Problem identification, field survey & literature/case study	20
Data collection, environmental audit & periodic reviews (project diary/log)	20
Analysis and design of remedial/preventive solution (technical work)	30
Project report	15
Final presentation, demonstration & viva-voce	15
Total	100

A minimum of 40% (40 marks) in CIE is required for a student to be declared as passed in the course.

Suggested Project Timeline:		
Weeks	Activity	Deliverable
1–2	Problem identification, site/field selection, need analysis	Problem statement & synopsis
3–5	Field surveys, case studies, data collection & environmental audit	Survey/audit data
6–10	Data analysis, design of remedial/preventive solution	Analysis & solution design
11–12	Validation/demonstration of measures, report writing	Project report & demo
13	Final presentation and viva-voce	Final evaluation

Reference Resources:

1. Y. Anjaneyulu, Introduction to Environmental Science, BS Publications.
2. Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses, UGC, Universities Press.
3. Central / State Pollution Control Board (CPCB / KSPCB) guidelines and reports — <https://cpcb.nic.in>
4. United Nations Sustainable Development Goals (SDGs) — <https://sdgs.un.org/goals>
5. Ministry of Environment, Forest and Climate Change (MoEFCC), Govt. of India — <https://moef.gov.in>

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Semester:IV						
PHYSICAL EDUCATION (SPORTS & ATHLETICS)– II						
Course Code	:	25PE2		CIE	:	100 Marks
Course Type	:	NCMC				
Total Hours	:	15 P				
Course Outcomes: At the end of the course, the student will be able to						
1. Understand the ethics and moral values in sports and athletics						
2. Perform in the selected sports or athletics of student’s choice.						
3. Understand the roles and responsibilities of organization and administration of sports and games.						
Module I: Ethics and Moral Values 4 Hours						
A. Ethics in Sports						
B. Moral Values in Sports and Games						
Module II : Specific Games (Any one to be selected by the student) 16 Hours						
A. Volleyball –Attack, Block, Service, Upper Hand Pass and Lowerhand Pass.						
B. Athletics (Track Events) –Any event as per availability of Ground.						
Module III : Role of organisation and administration 4 Hours						

Scheme and Assessment for auditing the course and Grades:

Sl.No.	Activity	Marks
1.	Participation of student in all the modules	20
2.	Quizzes/Assignment–2,eachof 20marks	40
3.	Final presentation/exhibition/Participation in competitions/ practical on specific tasks assigned to the students	40
Total		100

Semester IV			
Yoga - II			
Course Code	25YOG2	CIE	100 Marks
Course Type	NCMC		
Total Hours	2 hrs/week		
Course Objectives The objectives of this course are to: 1. Introduce students to the origin, history, philosophy, and fundamental concepts of Yoga. 2. Familiarize students with the different schools of Yoga, its aims, objectives, and the importance of prayer in Yogic practice. 3. Develop awareness of the rules, regulations, and safety precautions to be followed during Yogic practices. 4. Enable students to learn and practice Suryanamaskara and selected Yogasanas with proper techniques for improving physical and mental well-being. 5. Promote a healthy life style by encouraging regular Yogic practice, correcting misconceptions about Yoga, and fostering positive health, self-discipline, and overall wellness.			
Patanjali's Ashtanga Yoga: Patanjali's Ashtanga Yoga, its need and importance. Yama: Ahimsa, satya, asteya, brahmacharya, aparigraha, Niyama : shoucha, santosh, tapa, svaadhyaya, Eshvarapranidhan, Suryanamaskar 12 count 4 rounds. Different types of Asanas: Sitting 1. Sukhasana, 2.Paschimottanasana, Standing1. Ardhakati Chakrasana, 2.ParshvaChakrasana, Prone line 1. Dhanurasana Supine line 1. Halasana, 2. Karna Peedasana Kapalabhati: Meaning, importance and benefits of Kapalabhati. 40strokes/min3 rounds Pranayama-1. Suryanuloma-Viloma, 2.Chandranuloma-Viloma, 3-Suryabhedana, 4-Chandra Bhedana, 2.Nadishodhana, 3-BhramariPranayama, Meaning, Need, importance of Pranayama. Different types. Meaning by name, technique, precautionary measures and benefits of each Pranayama			
Course Outcomes: Upon successful completion of this course, the student will be able to: 1. Explain the origin, history, philosophy, objectives, and different schools of Yoga, along with its role in promoting holistic health and well-being. 2. Understand and apply the rules, regulations, and ethical practices associated with Yogic exercises, including the significance of prayer and Suryanamaskara. 3. Demonstrate the correct techniques of selected Yogasanas, such as sitting, standing, prone, and supine postures, while observing appropriate precautions. 4. Analyze the physical, mental, and therapeutic benefits of Yogic practices and distinguish between authentic Yogic practices and common misconceptions about Yoga. 5. Adopt Yoga as a regular life style practice to enhance physical fitness, mental wellness, discipline, and overall quality of life.			

Suggested Learning Resources: (TextBook/ReferenceBook/Manuals):**Text books:**

1. George Feuerstein: the yoga Tradition (its history, literature, philosophy and practice)
2. Sri Ananda: The complete Book of yoga Harmony of Body and Mind (Orient paper Backs: Vision Books Pvt.Ltd..1982.
3. B.K.Slyenkar: Light on the Yoga sutras of Patanjali (Haper Collins Publications India Pvt.Ltd.New Delhi.)
4. Science of Divinity and Realization of Self Vethathiri Publication,(6-11)WCSC,Erode

Reference books/Manuals:

1. Principles and Practice of Yoga in Health Care,Publisher:Handspring Publishing Limited. ISBN:9781909141209,978190914209
2. BasavaraddiV: Yoga in School Health, MDNIY NewDelhi. 2009
3. Dr.HR.Nagendra: Yoga Research and application (Vivekanda Kendra Yoga Prakashana Bangalore)
4. Dr.Shirley Telles: Glimpses of Human Body (Vivekanda KendraYoga Prakashana Bangalore).

Web links and Video Lectures (e-Resources):

Search by topics to get the videos

Assessment Structure:

This course is having only **Continuous Internal Assessment (CIE)** marks of 100.

Weightage	Marks
Attendance to all the sessions	20Marks
Practical sessions on Yoga and Its Benefits	40Marks
Two Assignments	40Marks
Total Marks	100

A student shall obtain a minimum of 40% marks or 40 marks out of 100 to qualify in the course.