RBU

RAMDEOBABA UNIVERSITY, NAGPUR

Formerly Shri Ramdeobaba College of Engineering & Management (RCOEM) Est. 1984

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RAMDEOBABA UNIVERSITY, NAGPUR–440013

(Formerly, Shri Ramdeobaba College of Engineering and Management, Nagpur 440013)

School of Engineering Sciences

Department of Mechanical Engineering

Teaching Evaluation Scheme and Syllabi

(As per National Education Policy-2020)

B.Tech. Mechanical Engineering

(With effect from Academic Year 2026-27)

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
Vision of the Department

Department of Mechanical Engineering aims to inculcate in students, a flair for excellence to become technological leader in industry and society.

Mission of the Department

1. To create the learning environment that stimulates students & faculty to enhance the knowledge in Mechanical Engineering.
2. To prepare the students to carry out research intended to cater the needs of the industry and society.

3. To march ahead with dedication, zeal and with a system responsive to the needs of all the stakeholders

Programme Educational Objectives (UG Program)

PEO 1: The graduates shall be capable to accept challenges in engineering industries.

PEO 2: The graduates shall demonstrate core competency to design, analyze and evaluate various engineering systems.

PEO 3: The graduates shall be able to apply computational and professional skills in corporate world.

PEO 4: The program shall prepare the graduates for higher studies, entrepreneurship and create awareness about lifelong learning.

Program Outcomes (POs)

PO1: 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.

PO2: Problem Analysis: Identify, formulate, review research literature and analyse complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The Engineer and The World: Analyse 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).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

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

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

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and

apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

*WK: Knowledge and Attitude Profiles.

Programme Specific Outcomes (PSO)

PSO1: Graduates will stand for design, production and operations in core mechanical domain and management of interdisciplinary applications.

PSO2: Graduates will be capable of carrying out the analysis of mechanical & allied systems and provide numerical and computer-based solution.

Semester I

SN	Course type	Course Code	Course Name	Hours/ week		Credit	Maximum Marks				ESE Duration
				L	P		Cont. Evaluation		End Sem Exam (E)	Total	(Hrs.)
							Th (I)	Pr (I+E)			
1	BSC	26HS03TP0107	Engineering Mathematics I	3	2	4	50	25+25	50	150	3
2	ESC	26EE07TP0106	Basics of Electrical Engineering	2	2	3	50	25+25	50	150	2
3	ESC	26ES04TH0101	Engineering Mechanics	3	0	3	50		50	100	3
4	ESC	26ES04TP0102	Engineering Graphics	2	2	3	50	25+25	50	150	2
5	ESC	26ES04TP0103	Fundamentals of Programming	4	2	5	50	25+25	50	150	3
6	AEC/HSSM	26HS02TP0101	Foundations of Business English	2	2	3	50	25+25	50	150	2
7	AEC/HSSM	26HS02TH0103-2	Foundational Course in Universal Human Values	1	0	1	50	0	0	50	0
TOTAL				17	10	22	350	250	300	900	15

I - Internal Evaluation, E - External Evaluation

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Syllabus and Scheme for Liberal/ Performing arts basket

Sr. no.	Course Code	Course Title	Lecture	Practical	Credits	Continuous Evaluation	End Sem Exam/ Internal Evaluation	Total	ESE Duration
1	26HS02PR0102-2	Fundamentals of Indian Classical Dance: Bharatnatayam	0	2	1	25	25	50	- -
2	26HS02PR0102-3	Fundamentals of Indian Classical Dance: Kathak	0	2	1	25	25	50	- -
3	26HS02PR0102-4	Introduction to Digital Photography	0	2	1	25	25	50	- -
4	26HS02PR0102-5	Introduction to Basic Japanese Language	0	2	1	25	25	50	- -
5	26HS02PR0102-6	Art of Theatre	0	2	1	25	25	50	- -
6	26HS02PR0102-7	Introduction to French Language	0	2	1	25	25	50	- -
7	26HS02PR0102-8	Introduction to Spanish Language	0	2	1	25	25	50	- -
8	26HS02PR0102-9	Art of Painting	0	2	1	25	25	50	- -
9	26HS02PR0102- 10	Art of Drawing	0	2	1	25	25	50	- -
10	26HS02PR0102- 11	Nature Camp	0	2	1	25	25	50	- -
11	26HS02PR0102- 12	Developing Self-awareness	0	2	1	25	25	50	- -
12	26HS02PR0102- 13	Art of Poetry	0	2	1	25	25	50	- -
13	26HS02PR0102-14	Creative and Content Writing	0	2	1	25	25	50	- -
14	26HS02PR0102-15	Science of life through Bhagwad Gita	0	2	1	25	25	50	- -
15	26HS02PR0102-16	Sanskrit Sambhashan-Spoken Sanskrit	0	2	1	25	25	50	- -
16	26HS02PR0102-17	Kirtan Kala	0	2	1	25	25	50	- -
17	26HS02PR0102- 18	Introduction to German Language and Culture	0	2	1	25	25	50	- -
18	26HS02PR0202-19	Adventure Sports	0	2	1	25	25	50	- -
19	26HS02PR0202-20	Introduction to Defense Forces & Obstacle Training	0	2	1	25	25	50	- -
20	26HS02PR0202-21	First Aid & Disaster Management	0	2	1	25	25	50	- -
21	26HS02PR0202-22	Basic Nutritional Course	0	2	1	25	25	50	- -
22	26HS02PR0202-23	Stress Management Through Yoga &Meditation	0	2	1	25	25	50	- -

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Semester II

SN	Course type	Course Code	Course Name	Hours/ week		Credit	Maximum Marks				ESE Duration (Hrs.)
				L	P		Cont. Evaluation		End Sem Exam (E)	Total	
							Th (I)	Pr (I +E)			
1	BSC	26HS03TH0217	Engineering Mathematics II	3	0	3	50	-	50	100	3
2	BSC	26HS05TP0203	Applied Physics	3	2	4	50	25+25	50	150	3
3	PCC	26ES04TH0201	Theory of Mechanisms & Elasticity	3	0	3	50	-	50	100	3
4	PCC	26ES04TP0202	Machine Drawing and Solid Modelling	2	2	3	50	25+25	0	100	-
5	ESC	26ES04TP0203	Data Structures	3	2	4	50	25+25	50	150	3
6	VSEC	26ES04TP0204	Fabrication Practices	1	2	2	50	25+25	0	100	-
7	SEC/ AEC	26ES04TH0205	Design Thinking	1	0	1	50	0	-	50	-
8	CCA	26HS02PR01 02-2 to 24	Liberal/Performing Arts	0	2	1	-	25	25	50	-
9	CCA	26HS04PR0201	Health-Fitness-Wellbeing (HFW)	0	2	1	0	25+25	0	50	-
TOTAL				16	12	22	350	275	225	850	12

I - Internal Evaluation, E - External Evaluation

Exit Option:

Exit option 1 : Award of Certificate in Major after the completion of 44 credits and an additional 8 credits, Finishing School Certificate for a UG certificate course on Industry 4.0 Technologies in association with TATA-Technologies Ltd .			L	P	C
Option	Certificate courses in association with TATA- Technologies Ltd on	Offline certification Course offered by RCOEM-TATA-CIIIT (RTC)	0	0	8
OR					

Option	One Month Internship at Industry/Project Work (one month)	As prescribed by Industry	0	0	8

Semester III

SN	Course type	Course Code	Course Name	Hours/ week		Credit	Maximum Marks				ESE Duration (Hrs.)
				L	P		Cont. Evaluation		End Sem Exam (E)	Total	
							Th (I)	Pr (I+E)			
1	BSC	26HS04TH0303	Probability & Statistics	3	0	3	50	-	50	100	3
2	PCC	26ES04TH0301	Thermodynamics	3	0	3	50	-	50	100	3
3	PCC	26ES04TP0302	Manufacturing Engineering	2	2	3	50	25+25	50	150	2
4	PCC	26ES04TP0303	Materials Science & Testing	2	2	3	50	25+25	50	150	2
5	ESC	26ES04TP0304	Programming with Python	2	2	3	50	25+25	0	100	0
6	OE	26ESOE04TH306	Open Elective-I/ MOOC	2	0	2	50	-	50	100	-
7	MDM	26ES04TH0307	MDM-I	3	0	3	50	-	50	100	3
8	VEC	26HS04TP0301	Environmental Science	1	2	2	50	-	-	50	-
			TOTAL	18	8	22	400	150	300	850	13

***Guidelines for Accelerated Degree Program:**

1. Outstanding/exceptional students (with a CGPA of 8.5 or above) may apply for the Accelerated Degree Program by applying along with a Statement of Purpose (SoP). Upon recommendation by the concerned department and approval from the competent authorities of RBU, such students may be permitted to complete an additional 30 credits by the end of the 6th semester.
2. The recommended NPTEL courses should preferably be aligned with the curriculum of the Program-Specific Electives and/or Program Core Courses offered in Semesters VII and VIII of the programs.
3. NPTEL courses of 4 week and 8 weeks duration may be considered equivalent to 2 and 4 credits, respectively.
4. Projects undertaken during the 4th, 5th, and 6th semesters shall be assigned additional weight age of 1, 2, and 3 credits, respectively.

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Semester IV

S N	Course type	Course Code	Course Name	Hours/ week		Credit	Maximum Marks				ESE Duration (Hrs.)
				L	P		Cont. Evaluation		End Sem Exam (E)	Total	
							Th (I)	Pr (I+E)			
1	PCC	26ES04TH0401	Mechanics of Solids	3	0	3	50	-	50	100	3
2	PCC	26ES04TP0402	Kinematics and Dynamics of Machinery	3	2	4	50	25+25	50	150	3
3	PCC	26ES04TP0403	Fluid Mechanics and Hydraulic Machines	3	2	4	50	25+25	50	150	3
4	PCC	26ES04TP0404	Manufacturing Technology	3	2	4	50	25+25	50	150	3
5	CEP/FP	26ES04PR0405	Project-1 (Mini project)	0	2	1	-	25+25	-	50	-
6	OE	26ESOE04TH0406	Open Elective-II/ MOOC	2	0	2	50	-	50	100	-
7	MDM	26ES04TH0407	MDM-II	3	0	3	50	-	50	100	3
8	SEC/AEC	26ES04AECPR0408	Prompt Engineering	0	2	1	-	25+25	-	50	-
9	AUDIT	26HS04PR0401	Self-Defence & Indian Martial Art	0	2	0					
			TOTAL	17	12	22	300	250	300	850	15

***Floating Credit: To be acquired before IV Semester**

Exit Option:

Exit option 2: Award of UG Diploma in Major after the completion of 88 credits and an additional 8 credits. Finishing School for a UG Diploma course of Machining Supervisor, in association with TATA-Technologies Ltd.					
1	A course for Certified Machining Supervisor	Offline certification Course	L	P	C
2	Prescribed Courses for Machining Supervisor	Online certification Course	0	0	8
3	One Month Internship at Industry/Project Work (one month)	As prescribed by Industry	0	0	8

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Semester V											
S N	Course type	Course Code	Course Name	Hours/ week		Credit	Maximum Marks				ESE Duration (Hrs.)
				L	P		Cont. Evaluation		End Sem Exam (E)	Total	
							Th (I)	Pr (I+E)			
1	PCC	26ES04TP0502	Mechanical Systems Design	3	2	4	50	25+25	50	150	3
2	PCC	26ES04TP0503	Heat Transfer	3	2	4	50	25+25	50	150	3
3	PCC	26ES04TP0504	Instrumentation and control	2	2	3	50	25+25	50	150	2
4	PSE	26ESPSE04TH0505	Program Specific Elective-I	3	0	3	50	25+25	50	150	3
5	OE	26ESOE04TH0506	Open Elective-III OR MOOC Course	2	0	2	50	0	50	100	-
6	MDM	26ES04TH0507	MDM-III	3	0	3	50	-	50	100	3
7	CEP/FP	26ES04PR0508	Project-II (Mini project)	0	2	1	-	25+25	-	50	-
8	SEC/AEC	26HS05TP0501	Business Communication	1	2	2	50	25+25	0	100	-
			Total	17	10	22	350	300	300	950	14

Program Specific Elective-I

Sem	Program elective	**Energy systems**	**Smart Manufacturing/Automation**	**System Engineering & Analytics**	**Robotics & AI**
V	1	Renewable energy system (26ESPSE04TH0505-2)	Additive Manufacturing (26ESPSE04TH0505-3)	Work system design (26ESPSE04TH0505-4)	Fundamentals of Robotics (26ESPSE04TH0505-5)

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Semester VI

S N	Course type	Course Code	Course Name	Hours/ week		Credit	Maximum Marks				ESE Duration
				L	P		Cont. Evaluation		End Sem Exam (E)	Total	(Hrs.)
							Th (I)	Pr (I+E)			
1	PCC	26ES04TH0601	Operations Research	3	0	3	50		50	100	3
2	PCC	26ES04TP0602	CAD & FEA	3	2	4	50	25+25	50	150	3
3	PCC	26ES04TP0603	Applied Thermal Engineering	3	2	4	50	25+25	50	150	3
4	PCC/IDE	26ES04PR0604	Product Innovation and Entrepreneurship	0	4	2		25+25		50	
5	SEC/AEC	26ESAEC04PR0605	Computer-Aided Product Design	0	2	1	-	25+25	-	50	-
6	PSE	26ESPSE04TH0606	Program Specific Elective-II (List specified)	3	0	3	50	0	50	100	3
7	MDM	26ES04TH0607	MDM-IV	3	0	3	50	-	50	100	3
8	Project	26ES04PR0608	Project-I	0	4	2		25+25	50	100	
			Total	15	14	22	250	250	300	800	15

***Floating Credit: To be acquired before VI Semester.**

*** Students with CGPA 7.5 and above can opt for one-year full time internship after completion of 6th Semester.**

Exit Option:

Exit option 3: Award of B.Sc. in Major after the completion of 132 credits and an additional 8 credits. Finishing school for B. Voc. Degree for a course on A Graduate/Trainee Mechanical Engineer, In association with TATA-Technologies Ltd. (132 Credits + 8 Credits)			L	P	C
1	A course for B. Voc. Degree in Mechanical Engineering	Offline certification Course	0	0	8
2	Prescribed Courses for B. Voc. Degree in Mechanical Engineering	Online certification Course	0	0	8
3	One Month Internship at Industry/Project Work (one month)	As prescribed by Industry	0	0	8

Program Specific Elective- II

Sem	Program elective	**Energy systems**	**Smart Manufacturing/Automation**	**System Engineering & Analytics**	**Robotics & AI**
VI	2	Battery Technology and Energy Storage Systems (26ESPSE04TH0606-2)	Geometric Dimensioning & Tolerancing (26ESPSE04TH0606-3)	Facilities Planning and Design (26ESPSE04TH0606-4)	Artificial Intelligence (26ESPSE04TH0606-5)

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Semester VII											
SN	Course type	Course Code	Course Name	Hours/ Week		Credit	Maximum Marks				ESE Duration
				L	P		Cont. Evaluation		End Sem Exam (E)	Total	(Hrs.)
							Th (I)	Pr (I+E)			
1	PCC	26ES04TP0701	Automation in Manufacturing	2	2	3	50	25+25	50	150	2
2	PCC	26ES04TP0702	Mechatronics	3	2	4	50	25+25	50	150	3
3	PSE	26ESPSE04TH0703	Program Specific Elective-III	3	0	3	50	0	50	100	3
4	PSE	26ESPSE04TH0704	Program Specific Elective-IV	3	0	3	50	-	50	100	3
5	Project	26ES04PR0705	Project II	0	8	4		50+50	100	200	
6	Audit Course	26ES04PR0706	Internship Evaluation	-	-	SF/ USF	-	-	-	-	-
7	SEC/AEC	26ES04PR0707	Participative Learning*	-	-	1	-	-	-	-	-
			Total	11	12	18	200	200	300	700	11
		26ES03PR0708	Internship Evaluation								
* Student will earn 1 credit against participative learning till VI semester / *Floating Credit: To be acquired before VII Semester											

*** Credit transfer through equivalent Global certification with prior approval by the Department**

Program Specific Elective- III & IV

Sem	Program elective	**Energy systems**	**Smart Manufacturing/Automation**	**System Engineering & Analytics**	**Robotics & AI**
VII	3	Energy Management (26ESPSE04TH0702-2)	Internet of Things and Automation (26ESPSE04TH0702-3)	Lean Manufacturing & Value Engineering (26ESPSE04TH0702-4)	Machine Learning (26ESPSE04TH0702-5)
VII	4	Electrical Vehicle Technology (26ESPSE04TH0703-2)	Sustainability and Green Manufacturing (26ESPSE04TH0703-3)	Engg Economics & Cost Control (26ESPSE04TH0703-4)	Mobile Robotics (26ESPSE04TH0703-5)

Programme Specific Electives

Sem	Program elective	**Energy systems#**	**Smart Manufacturing/Automation**	**System Engineering & Analytics**	**Robotics & AI**
V	1	Renewable energy system (26ESPSE04TH0505-1)	Additive Manufacturing (26ESPSE04TH0505-2)	Work system design (26ESPSE04TH0505-3)	Fundamentals of Robotics (26ESPSE04TH0505-4)
VI	2	Battery Technology and Energy Storage Systems (26ESPSE04TH0606-1)	Geometric Dimensioning & Tolerancing (26ESPSE04TH0606-2)	Facilities Planning and Design (26ESPSE04TH0606-3)	Artificial Intelligence (26ESPSE04TH0606-4)
VII	3	Energy Management (26ESPSE04TH0702-1)	Internet of Things and Automation (26ESPSE04TH0702-2)	Lean Manufacturing & Value Engineering (26ESPSE04TH0702-3)	Machine Learning (26ESPSE04TH0702-4)
VII	4	Electrical Vehicle Technology (26ESPSE04TH0703-1)	Sustainability and Green Manufacturing (26ESPSE04TH0703-2)	Engg Economics & Cost Control (26ESPSE04TH0703-3)	Mobile Robotics (26ESPSE04TH0703-4)

 # Not for the students, those who opted Minor in e-Mobility (BEST) offered by Electrical Engineering

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Semester: VIII											
S.No.	**Course Type**	**Course Code**	**Course Name**	**Hours/Week**		**Credits**	**Maximum Marks**			**Total**	**ESE Duration (Hrs)**
				L	**P**		**Continuous Assessment**		**End Semester**		
							TH (I)	**PR (I+E)**	**TH (E)**		
1	PCC	26ES04TH0801	Project Management	3	0	3	50	0	50	100	3
2	PCC	26ES04TH0802	Research Methodology	2	0	2	50	0	50	100	2
3	Project	26ES04PR0803	Major Project III	0	12	6	0	25+25	50	100	-
4	IKS	26HS02TH0804	Foundational Literature of Indian Civilization	1	0	1	50	0	0	50	-
Total				**6**	**12**	**12**	**150**	**50**	**150**	**350**	**5**
OR											
5	Project	26ES04PR0804	Full Semester Industry Internship	0	24	12		**175**	**175**	**350**	
OR											
6		26ES04PR0805	Research Internship	0	24	12		**175**	**175**	**350**	
OR											
7		26ES04PR0806	TBI Internship	0	24	12		**175**	**175**	**350**	
Total				0	24	12		**175**	**175**	**350**	

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One Year Internship

Semester: VII and VIII (B. Tech. Mechanical Engineering)											
S. No.	**Course Type**	**Course Code**	**Course Name**	**Hours/Week**		**Credits**	**Maximum Marks**			**Total**	**ESE Duration (Hrs)**
							Continuous Assessment		**End Semester**		
				L	**P**		**TH**	**PR**	**TH**		
One Year Internship Phase-I											
1	Internship	26ES03PR0709	Industry Internship Phase-I			12				350	
2	MOOC	26ES03PR0710	MOOC-I			3				175	3
3	MOOC	26ES03PR0711	MOOC-II			3				175	3
Total						**18**					**6**
One Year Internship Phase-II											
1	Internship	26ES03PR0807	Industry Internship Phase-II			12				**350**	

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Breakup of Semester wise Credits*

Semester	Lecture	Practical	Credits	Continuous Evaluation	ESE Marks	Total Marks	No of Exams	Hours of ESE	Theory Credits	Lab Credits
I	17	10	22	600	300	900	6	15	17	5
II	16	12	22	625	225	850	4	12	16	6
III	18	08	22	550	300	850	5	13	18	4
IV	17	12	22	550	300	850	5	15	17	5
V	17	10	22	650	300	950	5	14	17	5
VI	15	14	22	500	300	800	5	15	15	7
VII	11	12	18	400	300	700	4	11	11	7
VIII	6	12	12	200	150	350	2	5	6	6
Total	**117**	**90**	**162**	**4075**	**2175**	**6250**	**36**	**100**	**117**	**45**

***The Course Code & Course name may be changed based on the approval of the Board of Studies experts & Committee**

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Open Elective- MOOCS for Coursera										
SN	Sem	Course Code	Course Name	Hours/ week		Credit	Maximum Marks			ESE Duration Exam
				L	P		Cont. Evaluation	End Sem Exam	Total	
1	III	26ESOE04TH0306	Cyber Security in Manufacturing (22 Hour) Industry 4.0 and its impact on manufacturing sector (20 Hour)	2	0	2	50	50	100	2
2	IV	26ESOE04TH0406	Six Sigma Principles (13 Hour) Supply Chain Management and Analytics (34 Hour)	2	0	2	50	50	100	2
3	V	26ESOE04TH0506	Major Engineering Projects: Governance, Risk and Scope (24 Hours) Financing and Initiating Major Engineering Projects (21 Hours)	2	0	2	50	50	100	2
TOTAL				6	0	6	150	150	300	6

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Honors Scheme (Design and Computational Engineering)

SN	Sem	Course Code	Course Name	Hours/ week		Credit	Maximum Marks			ESE Duration Exam
				L	P		Cont. Evaluation	End Sem Exam	Total	
1	III	26ES04HT0301	Hydraulics and Pneumatics	3	0	3	50	50	100	3
2	IV	26ES04HT0401	Mechanical Vibrations	3	0	3	50	50	100	3
3	V	26ES04HT0501	Stress Analysis	4	0	4	50	50	100	3
4	VI	26ES04HT0601	Introduction to CFD	4	0	4	50	50	100	3
5	VII	26ES04HP0701	Project	0	8	4	50	50	100	0
			TOTAL	14	8	18	250	250	500	12

Students can choose 8-12 weeks NPTEL-Swayam Courses, pre-approved from Program/Course Coordinator instead of the above.

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Minor Scheme offered by ME: Mechanical Systems and Technology										
SN	Sem	Course Code	Course Name	Hours/ week		Credit	Maximum Marks			ESE Duration Exam
				L	P		Cont. Evaluation	End Sem Exam	Total	
1	III	26ES04MT0301	Computer Aided Design	3	0	3	50	50	100	3
2	IV	26ES04MT0401	Digital manufacturing	3	0	3	50	50	100	3
3	V	26ES04MT0501	Renewable Energy Resources	4	0	4	50	50	100	3
4	VI	26ES04MT0601	Operation Research	4	0	4	50	50	100	3
5	VII	26ES04MP0701	Project	0	8	4	50	50	100	
			TOTAL	14	8	18	250	250	500	12

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Session: 2026-27

Minor Scheme available for Mechanical Engineering students offered by EE: e-Mobility (BEST)										
SN	Sem	Course Code	Course Name	Hours/ week		Credits	Maximum Marks			ESE Duration Exam
				L	P		Cont. Evaluation	End Sem Exam	Total	
1	III	26EE04MT0301	Foundation of EV (e-Mobility)	3	0	3	50	50	100	3
2	IV	26EE04MT0401	Battery Pack Design and BMS	3	0	3	50	50	100	3
3	V	26EE04MT0501	EV Charger Development and Testing	4	0	4	50	50	100	3
4	VI	26EE04MT0601	Motor Design Drive Testing	4	0	4	50	50	100	3
5	VII	26EE04MP0701	Vehicle Testing	0	8	4	50	50	100	
			TOTAL	14	8	18	250	250	500	12

Bajaj Engineering Skills Training (BEST)

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Department of Mechanical Engineering

Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering

Session: 2026-27

Minor Scheme available for Mechanical Engineering students offered by EE: Nuclear Engineering Systems

SN	Sem	Course Code	Course Name	Hours/ week		Credits	Maximum Marks			ESE Duration Exam
				L	P		Cont. Evaluation	End Sem Exam	Total	
1	III	26EE04MT0301	Nuclear Fundamentals -I	3	0	3	50	50	100	3
2	IV	26EE04MT0401	Nuclear Fundamentals -II	3	0	3	50	50	100	3
3	V	26EE04MT0501	Nuclear Measurements and Instrumentations	4	0	4	50	50	100	3
4	VI	26EE04MT0601	Nuclear Power Plant Engineering / Industrial Applications of Nuclear Energy	4	0	4	50	50	100	3
5	VII	26EE04MP0701	Industrial Applications of Nuclear Energy	0	8	4	50	50	100	
			TOTAL	14	8	18	250	250	500	12

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Minor: IOT (Offered by ECS to B. Tech. ME)

Sr. No.	Sem	Course Code	Course Title	Hours/week		Credits	Maximum marks			ESE Duration (Hrs)
				L	P		Continuous Evaluation	End Sem Exam	Total	
1	III	26EE10MT0301	IoT Fundamentals	3	0	3	50	50	100	3
2	IV	26EE10MT0401	Sensor Interfacing with Arduino and ESP8266	3	0	3	50	50	100	3
3	V	26EE10MT0501	Cloud Computing Using Raspberry Pi	4	0	4	50	50	100	3
4	VI	26EE10MT0601	Data Management and Analytics for IoT	4	0	4	50	50	100	3
5	VII	26EE10MP0701	Project	0	8	4	50	50	100	3
			Total	**14**	**8**	**18**	**250**	**250**	**500**	**18**

Minor: (Offered by CSE to B. Tech. ME)

Sr. No.	Sem	Course Code	Course Title	Hours/week		Credits	Maximum marks			ESE Duration (Hrs)
				L	P		Continuous Evaluation	End Sem Exam	Total	
1	III	26CS01MT0301	Programming for Problem Solving	3	0	3	50	50	100	3
2	IV	26CS01MT0401	Tools & Techniques of Artificial Intelligence	3	0	3	50	50	100	3

3	V	26CS01MT0501	Exploratory Data Analysis	4	0	4	50	50	100	3
4	VI	26CS01MT0601	Fundamentals of Machine Learning	4	0	4	50	50	100	3
5	VII	26CS01MP0701	Project	0	8	4	50	50	100	3
			Total	**14**	**8**	**18**	**250**	**250**	**500**	**18**

Minor: (Offered by ECE to B. Tech. ME)

Sr. No.	Sem	Course Code	Course Title	Hours/week		Credits	Maximum marks			ESE Duration (Hrs)
				L	P		Continuous Evaluation	End Sem Exam	Total	
1	III	26EE05MT0301	Fundamentals of Communication Engineering	3	0	3	50	50	100	3
2	IV	26EE05MT0401	Sensors for Intelligent Instrumentation	3	0	3	50	50	100	3
3	V	26EE05MT0501	IoT for Industrial Application	4	0	4	50	50	100	3
4	VI	26EE05MT0601	Future Generation Networks	4	0	4	50	50	100	3
5	VII	26EE05MP0701	Project	0	8	4	50	50	100	3
			Total	**14**	**8**	**18**	**250**	**250**	**500**	**18**

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Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering

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Multi-Disciplinary Minor (MDM) offered by ME to other department students: Manufacturing Systems and Productivity Engineering

Sr. No.	Sem	Course Code	Course Title	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
				L	P	S		Continuous Evaluation	End Sem Exam	Total	
1	III	26ES04TH0307	Basics of Mechanical Engineering	3	0	0	3	50	50	100	3
2	IV	26ES04TH0407	Manufacturing Engineering	3	0	0	3	50	50	100	3
3	V	26ES04TH0507	Productivity Improvement Techniques	3	0	0	3	50	50	100	3
4	VI	26ES04TH0607	Smart Manufacturing and Industry 4.0	3	0	0	3	50	50	100	3
			TOTAL	**12**	**0**	**0**	**12**	200	200	400	12

Multi-Disciplinary Minor (MDM) offered by EE to ME students: Basics of Nuclear Systems

Sr. No.	Sem	Course Code	Course Title	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
				L	P	S		Continuous Evaluation	End Sem Exam	Total	
1	III	26EE04TH0307	Nuclear Concepts-I	3	0	0	3	50	50	100	3
2	IV	26EE04TH0407	Nuclear Concepts-II	3	0	0	3	50	50	100	3
3	V	26EE04TH0507	Basics of Nuclear Measurements	3	0	0	3	50	50	100	3
4	VI	26EE04TH0607	Nuclear Security and Safeguards	3	0	0	3	50	50	100	3
			TOTAL	**12**	**0**	**0**	**12**	200	200	400	12

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Multi-Disciplinary Minor (MDM): Robotics (Offered by RAI to B. Tech. ME)

Sr. No.	Sem	Course Code	Course Title	Hours/week		Credits	Maximum marks			ESE Duration (Hrs)
				L	P		Continuous Evaluation	End Sem Exam	Total	
1	III	26ES03TH0307-2	Fundamentals of Robotics	3	0	3	50	50	100	3
2	IV	26ES03TH0407-2	Kinematics of Robots	3	0	3	50	50	100	3
3	V	26ES03TH0507-2	Mobile Robotics	3	0	3	50	50	100	3
4	VI	26ES03TH0607-2	Drone Technology	3	0	3	50	50	100	3
			Total	**12**	**0**	**12**	**200**	**200**	**400**	**12**

Multi-Disciplinary Minor (MDM): Embedded systems and IoT (Offered by ECE dept. to B. Tech. ME)

Sr. No.	Sem	Course Code	Course Title	Hours/week		Credits	Maximum marks			ESE Duration (Hrs)
				L	P		Continuous Evaluation	End Sem Exam	Total	
1	III	26EE05TH0306-1	Sensors for IoT	3	0	3	50	50	100	3
2	IV	26EE05TH0408-1	Microcontrollers and IoT Applications	3	0	3	50	50	100	3
3	V	26EE05TH0507-1	IoT System Architecture	3	0	3	50	50	100	3
4	VI	26EE05TH0608-1	Use Cases of IoT	3	0	3	50	50	100	3
			Total	**12**	**0**	**12**	**200**	**200**	**400**	**12**

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Multi-Disciplinary Minor (MDM): Mobile Communication (Offered by ECE dept. to B. Tech. ME)

Sr. No.	Sem	Course Code	Course Title	Hours/week		Credits	Maximum marks			ESE Duration (Hrs)
				L	P		Continuous Evaluation	End Sem Exam	Total	
1	III	26EE05TH0306-2	Fundamentals of Communication	3	0	3	50	50	100	3
2	IV	26EE05TH0408-2	Cellular Communication	3	0	3	50	50	100	3
3	V	26EE05TH0507-2	LTE Technologies	3	0	3	50	50	100	3
4	VI	26EE05TH0608-2	5G and 6G Systems	3	0	3	50	50	100	3
			Total	**12**	**0**	**12**	**200**	**200**	**400**	**12**

Multi-Disciplinary Minor (MDM): IoT for Environmental Sustainability (Offered by ECS to B. Tech. ME)

Sr. No.	Sem	Course Code	Course Title	Hours/week		Credits	Maximum marks			ESE Duration (Hrs)
				L	P		Continuous Evaluation	End Sem Exam	Total	
1	III	26EE01TH0305-1	Introduction to IoT system Design	3	0	3	50	50	100	3
2	IV	26EE01TH0405-1	Programming for Environmental IoT	3	0	3	50	50	100	3
3	V	26EE01TH0505-1	IoT Privacy and Security	3	0	3	50	50	100	3
4	VI	26EE01TH0505-1	Use cases of Environmental IoT	3	0	3	50	50	100	3

			Total	**12**	**0**	**12**	**200**	**200**	**400**	**12**

Multi-Disciplinary Minor (MDM): Integrated Circuit Design (IC design) (Offered by ECS to B. Tech. ME)

Sr. No.	Sem	Course Code	Course Title	Hours/week		Credits	Maximum marks			ESE Duration (Hrs)
				L	P		Continuous Evaluation	End Sem Exam	Total	
1	III	26EE01TH0305-2	Basics of Chip Design using Verilog HDL	3	0	3	50	50	100	3
2	IV	26EE01TH0405-2	MIPS Processor Design and Testing	3	0	3	50	50	100	3
3	V	26EE01TH0505-2	Chip Verification using System Verilog	3	0	3	50	50	100	3
4	VI	26EE01TH0605-2	VLSI Physical Design	3	0	3	50	50	100	3
			Total	**12**	**0**	**12**	**200**	**200**	**400**	**12**

Multi-Disciplinary Minor (MDM) offered by CSE: Web Development (Offered to B. Tech. ME)

Sr. No.	Sem	Course Code	Course Title	Hours/week		Credits	Maximum marks			ESE Duration (Hrs)
				L	P		Continuous Evaluation	End Sem Exam	Total	
1	III		Introduction to Web Development	3	0	3	50	50	100	3

2	IV		Front End Development	3	0	3	50	50	100	3
3	V		Backend Technologies	3	0	3	50	50	100	3
4	VI		Cloud Technologies	3	0	3	50	50	100	3
			Total	**12**	**0**	**12**	**200**	**200**	**400**	**12**

Multi-Disciplinary Minor (MDM): Cloud Computing (Offered by CSE to B. Tech. ME)

Sr. No.	Sem	Course Code	Course Title	Hours/week		Credits	Maximum marks			ESE Duration (Hrs)
				L	P		Continuous Evaluation	End Sem Exam	Total	
1	III		Introduction to Cloud Computing + Google Cloud Foundation Certificate	3	0	3	50	50	100	3
2	IV		Data Analytics + Google Cloud Data Analytics Certificate	3	0	3	50	50	100	3
3	V		Cloud Engineering +Google Cloud Engineer Certificate	3	0	3	50	50	100	3
4	VI		Cloud Security Fundamentals + Google Cloud Cyber Security Certificate	3	0	3	50	50	100	3
			Total	**12**	**0**	**12**	**200**	**200**	**400**	**12**

Multi-Disciplinary Minor (MDM): Cyber Security (Offered by CSE to B. Tech. ME)

Sr.				Hours/week		Credi	Maximum marks			ESE

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No.	Sem	Course Code	Course Title	L	P		Continuous Evaluation	End Sem Exam	Total	Duration (Hrs)
1	III		Fundamentals of Network Security	3	0	3	50	50	100	3
2	IV		Applied Cyber Defence	3	0	3	50	50	100	3
3	V		Modern Cloud Security Architecture	3	0	3	50	50	100	3
4	VI		Digital Forensics	3	0	3	50	50	100	3
			Total	**12**	**0**	**12**	**200**	**200**	**400**	**12**

Multi-Disciplinary Minor (MDM): Civil Engineering for Sustainable Development (Offered by Civil Engg. to B. Tech. ME)

Sr. No.	Sem	Course Code	Course Title	Hours/week		Credits	Maximum marks			ESE Duration (Hrs)
				L	P		Continuous Evaluation	End Sem Exam	Total	
1	III	26ES01TH0305	Fundamentals of Civil Infrastructure and Construction	3	0	3	50	50	100	3
2	IV	26ES01TH0404	Construction Materials and Technology	3	0	3	50	50	100	3
3	V	26ES01TH0506	Green Building Construction and Environmental Systems	3	0	3	50	50	100	3
4	VI	26ES01TH0607	Building Construction Methods and	3	0	3	50	50	100	3

			Management							
			Total	**12**	**0**	**12**	**200**	**200**	**400**	**12**

Multi-Disciplinary Minor (MDM): Renewable Energy and E-mobility (Offered by Electrical Engg. to B. Tech. ME)

Sr. No.	Sem	Course Code	Course Title	Hours/week		Credits	Maximum marks			ESE Duration (Hrs)
				L	P		Continuous Evaluation	End Sem Exam	Total	
1	III	26EE07TH0309	Introduction to Renewable Energy Sources	3	0	3	50	50	100	3
2	IV	26EE07TH0409	EV Architecture and Components	3	0	3	50	50	100	3
3	V	26EE07TH0509	Energy Storage Systems in E-Mobility	3	0	3	50	50	100	3
4	VI	26EE07TH0609	Autonomous Vehicle	3	0	3	50	50	100	3
			Total	**12**	**0**	**12**	**200**	**200**	**400**	**12**

Multi-Disciplinary Minor (MDM) offered by MBA to ME students: **Project Management**

Sr. No.	Sem	Course Code	Course Title	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
				L	P	S		Continuous Evaluation	End Sem Exam	Total	

1	III	26MT04TH0307	Introduction to Engineering Project Management	3	0	0	3	50	50	100	3
2	IV	26MT04TH0407	Project Planning, Scheduling, and Cost Control	3	0	0	3	50	50	100	3
3	V	26MT04TH0507	Engineering Project Risk, Quality, and Leadership	3	0	0	3	50	50	100	3
4	VI	26MT04TH0607	Advanced Project Management & Capstone for Engineers	3	0	0	3	50	50	100	3
			TOTAL	**12**	**0**	**0**	**12**	200	200	400	12

B.Tech. Mechanical Engineering

Programme Syllabus

Semester-I

Course Code	Course Title				Category
26HS03TP0107	**Engineering Mathematics I**				BSC
Contact Hours per Week			CA	FE	Credits
L	P	S			
3	1	1	50+50	50	04

Prerequisite: Students should possess basic knowledge of Mathematics, including algebra, trigonometry, and elementary calculus and basic knowledge of computer.

Course Objectives:

The objective of this course is to develop a strong foundation in differential equations, statistics, probability, and differential calculus, with a focus on their applications in Mechanical and Robotics &AI Engineering. The course integrates theoretical concepts with computational lab-based experiments to enhance students' ability to model, analyze, and solve engineering problems using mathematical and simulation tools.

Course Outcomes:

On successful completion of the course, the students will able to:

1. Solve and analyze first-order ordinary differential equations and apply them to model engineering problems using computational tools.
2. Formulate and solve higher-order differential equations using analytical techniques and interpret their applications through graphical models.
3. Analyze and interpret engineering data using curve fitting, regression, and correlation techniques to identify patterns and relationships.
4. Apply differential calculus methods to solve engineering problems and use computational tools to model and optimize systems involving several variables.
5. Construct and solve partial differential equations related to engineering boundary value problems and simulate their behavior using computational visualization techniques.
6. Implement fundamental matrix operations to simulate and interpret applications in fields such as image processing, computer graphics.

UNIT I: First order ordinary differential equations	**7 Hours**

Exact, linear and Bernoulli's equations, Euler's equations, Equations of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type, Applications of First order Differential Equations.

UNIT II: Ordinary differential equations of higher orders	**7 Hours**

Second order linear differential equations with constant and variable coefficients, method of variation of parameters, Cauchy-Euler equation. Applications of Higher order Differential Equations.

UNIT III: Statistics	**6 Hours**

Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves, correlation and regression – Rank correlation, Multiple regression and correlation and its application in Engineering

UNIT IV: Differential Calculus	**8 Hours**

Taylor's and Maclaurin's series expansions, radius of curvature (Cartesian form), evolutes and involutes, Limit and continuity of functions of several variables and their partial derivatives, Eulers Theorem, chain rule, total derivative, Jacobians, Maxima, minima and saddle points; Method of Lagrange multipliers.

Unit V: Partial Differential Equations	**8 Hours**

Introduction to PDE , solution of homogeneous PDE, solution of PDE with separation of variables, ,boundary value problems: vibrations of a string, heat equation, potential equation, vibrations of circular membranes.

Experiments:

Exp. No.	Name of Experiments	Mapped COs
1	To use mathematical software as an advance calculator	**CO1**
2	Graphical Representation of 2D Functions Relevant to Engineering Models	**CO1,CO2, CO3**
3	3D Plotting Techniques for Visualizing ODE-related Engineering Models	**CO1,CO2, CO3**
4	Analyzing Data Trends through Curve Fitting Techniques	**CO3**
5	Visualization and Interpretation of Differential Equation Solutions.	**CO1,CO2,CO5**
6	Differential Calculus Techniques for Modelling Engineering behaviour	**CO4**
7	Applied optimization (Maxima, minima and Gradient descent method)	**CO4**
8	Matrix Computations with various Applications	**CO6**

Textbooks

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000

2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

References:

1. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley India, 2009

2. A text book of Applied Mathematics Volume I & II, by P. N. Wartikar and J. N. Wartikar, Pune VidhyarthiGrihaPrakashan, Pune-411030 (India).

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Course Code	Course Title				Category
26EE07TP0106	Basics of Electrical Engineering				ESC
Contact Hours per Week			CA	FE	Credits
L	P	S			
2	2	2	50+50	50	3

Prerequisite:

Course Objectives:

The objective of this course is to provide mechanical engineering students with a comprehensive understanding of electrical and electronics principles and their application in electromechanical systems.

Additionally, the course will explore various case studies to demonstrate the real-world applications of these concepts in industries such as automation, electric vehicles, and medical devices.

Course Outcomes: On successful completion of the module students will be able to:

1. Explain the basics of Electrical systems and various components.
2. Identify the various components in Electro-mechanical systems.
3. Classify the types of power converters as per the applications.
4. Select the battery for specific application.

UNIT I: INTRODUCTION TO ELECTRICAL SYSTEM — **7 Hours**

DC Circuits: Electrical circuit elements (R, L and C), voltage and current sources, Kirchhoff's current and voltage laws, analysis of simple circuits with DC excitation.

AC Circuits: Representation of sinusoidal wave forms, peak and RMS values. Concept of Impedance, Power, Energy. Introduction to 3-phase systems

UNIT II: INTRODUCTION TO POWER CONVERTERS — **7 Hours**

Basic schematic introduction to power converters, Types of Power converter, AC-DC, DC-DC, DC-AC converters, applications

UNIT III: ELECTRICAL MACHINES — **8 Hours**

Introduction to DC motors

Single Phase Transformer: Construction, principle of operation, EMF Equation. Regulation and Efficiency of a Transformer.

Three Phase Induction Motor: Construction and Principle of Operation, Slip and Torque, Speed Characteristics.

Stepper motor: Construction, working principle and modes of operation

UNIT IV: ELECTROMECHANICAL SYSTEMS — **8 Hours**

Introduction to electromechanical systems: Basics of electric motors, actuators, and sensors, Design considerations for integrating electrical and mechanical components, Applications of power electronics in mechanical systems. Selection and sizing of motors for mechanical systems, Motor control techniques and applications.

TEXT BOOKS:

1. D. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
2. Electrical Technology: B. L. Thereja, S. Chand Publications.

3. Electrical & Electronic Instruments & Measurement by A. K. Sawhney, Dhanpat Rai and Co. 19th Edition, 2015.
4. Mechatronics: Principles, Concepts and Applications, Mahalik N. P., Tata McGraw Hill

REFERENCE BOOKS:

1. D. C. Kulshreshtha, "Basic Electrical Engineering", McGrawHill,2009.
2. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
3. Basic Electrical Engineering: S.B. Bodkhe, N. M. Deshkar, P. P. H. Pvt. Ltd.
4. Electronic Instrumentation & Measurement Technique by W. D. Cooper & A. D. Helfrick, Prentice Hall, 3rd revised Edition, 1985.

Course Outcomes: On successful completion of the module students will be able to:

1. Perform experiments on basis DC and AC circuits and make valid conclusions from observed results.
2. Study the operation of DC-DC converters.
3. To reverse the direction of rotation of a dc shunt motor and control it's speed by different methods.
4. Calculate the energy bill and verify the same with that provided by the utility for a specific installation and specific period.
5. Write effective reports based on observations and conclusions.

List of Experiments:

1. To verify Kirchhoff's laws of DC circuits.
2. To verify Kirchhoff's laws for RLC series circuits.
3. To verify Kirchhoff's laws for RLC parallel circuits.
4. To study DC – DC Buck converter.
5. To study DC – DC Boost converter.
6. To study battery charging.
7. Study of actuators and sensors for electro-mechanical systems.
8. To calculation and verification of energy bill of a house.
9. To reverse the direction of rotation of a dc shunt motor and control it's speed by different methods.
10. To measure power in DC circuit using shunt and voltage divider circuit.
11. To study the charging/ discharging characteristics of super capacitor.
12. Open-ended experiments.

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Course Code	Course Title				Category
26ES04TH0101	**Engineering Mechanics**				**PCC**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	**0**	**1**	**50**	**50**	**03**

Prerequisite: Students should possess basic knowledge of Mathematics, including algebra, trigonometry, and elementary calculus, along with an understanding of Physics fundamentals such as force, motion, and Newton's laws. They should also be familiar with vector operations like addition and subtraction, and have an elementary understanding of units and measurements.

Course Objectives:

After completing this course, students will be able to:

1. Develop a strong foundation in force systems, equilibrium, and vector mechanics for engineering applications.
2. Understand and analyse frictional forces and mechanical properties such as centroid and moment of inertia.
3. Apply principles of kinematics and kinetics to study motion of particles.
4. Analyse mechanical systems using work-energy and impulse-momentum principles.
5. Understand and solve problems related to motion and dynamics of rigid bodies in engineering systems.

Course Outcomes:

After successful completion of the course, students will be able to:

CO1: Apply concepts of **force systems, equilibrium, and free body diagrams (FBD)** to analyse engineering problems including trusses and structures.

CO2: Evaluate **frictional forces and compute centroid, centre of gravity, and moment of inertia** for simple and composite bodies.

CO3: Analyse **motion of particles** using kinematic and kinetic principles including Newton's laws and projectile motion.

CO4: Apply **work-energy and impulse-momentum principles** to solve problems involving particle motion and systems.

CO5: Analyse **kinematics and kinetics of rigid bodies**, including rotation, rolling motion, and general plane motion.

UNIT I: Basics of Mechanics & Force Systems	**8 Hours**

Introduction and need of Engineering Mechanics, Units of Measurement, Force Vectors, Vector Addition of Forces, Equilibrium of a Particle, Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams (FBD), Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy.

Introduction to Trusses: Structural Analysis of Simple Trusses by joint and section method. Introduction to space trusses, frames.

UNIT II: Friction and Properties of Surfaces & Solids	**8 Hours**

Friction: Basics of friction, Application of friction phenomenon, ladder friction, wedge friction, rolling resistance.

Properties of Surfaces & Solids: Centroid and Centre of Gravity covering, Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its

implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia.

UNIT III: Dynamics of Particle	**8 Hours**

Kinematics of a Particle: Introduction to kinematics**,** Rectilinear motion, General Curvilinear Motion, Two-dimensional motion with constant acceleration, Uniform circular motion, Tangential and normal acceleration, Projectile motion.

Kinetics of a Particle: Newton's Second Law of Motion, D'Alembert Principle, Motion of connected bodies (block, pulleys, etc) with and without friction, linear and angular momentum.

UNIT IV: Work-Energy and Impulse-Momentum Principle	**8 Hours**

Work-Energy Principle: The Work of a Force, Principle of Work and Energy for translation, Work-Energy applied to particle motion and connected system and fixed axis rotation, Power and Efficiency, Conservation of Energy.

Impulse-Momentum Principle: Principle of Linear Impulse and Momentum, Angular Momentum, Relation between Moment of a Force and Angular Momentum, Principle of Angular Impulse and Momentum, Principle of Linear Impulse and Momentum for a System of Particles

Unit V: Dynamics of Rigid Body	**8 Hours**

Kinematics of a Rigid Body: Introduction, Types of rigid body motion: translation, rotation about fixed axis, general plane Motion.

Kinetics of rigid body: Introduction, Newton's Second Law of Motion for rotational motion, Equation of translational motion, Equation of rotational motion Fixed-axis rotation, Rolling Bodies, General Plane Motion.

TEXT BOOKS:

1. R. C. Hibbler, Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
2. F. L. Singer, Engineering Mechanics, Statics & Dynamics, BS Publications

REFERENCE BOOKS:

1. Irving H. Shames, Engineering Mechanics – Statics and Dynamics, Pearson Educations, Forth edition, 2003.
2. Beer and Johnson, Vector Mechanics for Engineers, Vol.1 "Statics" and Vol.2 "Dynamics, McGraw Hill International Edition, 1995.
3. S.S. Bhavikatti, Engineering Mechanics, New Age Publications

Ramdeobaba University, Nagpur

Department of Mechanical Engineering

Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering

Session: 2026-27

Course Code	Course Title				Category
26ES04TP0102	**Engineering Graphics**				ESC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
2	2	2	50	50	3

Prerequisite: Nil

Course Objectives:

The objective of the course is to prepare the students:

1. To develop the ability of visualization of different objects through technical drawings.

2.To acquire computer drafting skills for communication of concepts, ideas in the design of engineering products.

Course outcomes

At the end of this course students will be able to:

1. Draw and interpret technical drawings

2. Convert 2-D to 3-D drawing and vice versa.

3. Draw the projection of points and lines located in different quadrants.

4. Develop the solid surface for sheet metal working

5. Use & demonstrate drafting package.

UNIT I: Introduction to Engineering Drawing and Engineering Curves	**5 Hrs.**
Principles of Engineering Graphics and their significance, usage of drawing instruments, Lettering and dimensioning, Engineering Curves - Conic sections, Cycloid and Involute etc.	
UNIT II: Orthographic Projections	**6 Hrs.**
Orthographic Projections: Theory of Projections, Concept of Projection, and First & Third angle projection methods. Conversion of given 3-dimensional view to 2-dimensional representation.	
UNIT III: Projections of Lines and Planes	**6 Hrs.**
Projections of Lines and Planes: Projections of lines (line inclined to both planes), Projections of planes (inclined to both the planes), Concept of auxiliary plane method for projections of the plane.	
UNIT IV: Sections of Solids and Development of Surfaces	**7 Hrs.**
Sections of Solids and Development of Surfaces: Projection of solids, Theory of sectioning, sections of prism, pyramid, cylinder and cone, Development of lateral surfaces of solids, Real-world applications of surface development.	
UNIT V: Isometric Projections	**6 Hrs.**

Isometric Projections: Principles of Isometric projection - Isometric Scale, Isometric View, and Conversion of Orthographic views to Isometric Views / Projection.

Text Books:

1. Agarwal B & Agarwal C.M. Engineering Graphics, Tata McGraw Hill Publications.

2. Engineering Drawing by N.D. Bhatt, Charotar Publishing House Pvt. Ltd.

3. Engineering Drawing with an Introduction to AutoCAD" by D. A. Jolhe Tata McGraw Hill

Publications

4. Engineering Drawing by R.K. Dhawan, S. Chand Publications

5. Engineering Drawing by K.L. Narayana & P. Kannaiah, SciTech Publication

Reference Books:

1. AutoCAD 14 for Engineering Drawing by P. Nageshwara Rao, Tata McGraw Hill Publications.

2. A text book of Engineering Drawing by P.S. Gill, S.K. Kataria & sons, Delhi.

3. Engineering Drawing and Computer Graphics by M. B. Shah & B.C. Rana, Pearson Education.

Engineering Graphics Lab

Course Code: 26ES04TP0102

Introduction to Computer Aided Drawing:

Introduction, Drawing Instruments and their uses, relevant BIS conventions and standards. Lettering, line conventions, dimensioning, material conventions and free hand practicing. Computer screen, layout of the software, standard tool bar / menu and description of most commonly used tool bars, and navigational tools.
Co-ordinate system and reference planes HP, VP, RPP & LPP of 2D/3D environment. Selection of drawing sheet size and scale.
Commands and creation of lines, coordinate points, axes, poly-lines, square, rectangle, Polygon,
splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet, curves, constraints viz., tangency, parallelism, inclination and perpendicularity.
Practical's to be performed from the list as below

List of sheets

1 Engineering Curves
2 Orthographic Projection
3 Projection of Straight Lines and Planes
4 Section of solids and Development of surfaces
5 Isometric projection

Course Code	Course Title	Category

26ES04TP0103	FUNDAMENTALS OF PROGRAMMING				PCC
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
04	02	02	50 (T) + 50 (P)	50 (T)	04 + 01 = 05
Prerequisite: Nil					

Course Objectives

The course aims to:

- Develop fundamental programming skills using C and C++ languages
- Understand basic data structures and algorithms
- Learn structured and object-oriented programming concepts
- Build problem-solving capabilities through programming exercises
- Apply learned concepts to solve real-world coding problems

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Apply fundamental C programming concepts including data types, operators, control structures, and functions to develop modular programs that solve computational problems.

CO2: Analyze computational problems and design efficient solutions using arrays, strings, pointers, and structures with appropriate memory management and algorithmic techniques.

CO3: Evaluate programming solutions by analyzing algorithm complexity, memory management strategies, and determining optimal approaches for searching, sorting, and data manipulation.

CO4: Design and develop object-oriented programs in C++ using classes, constructors, destructors, inheritance, and operator overloading for code reusability and functionality.

UNIT 1: Fundamentals of C Programming (10 hours)

1.1 Introduction to Programming and C Language (1 hour)

- Evolution and features of C language
- Structure of a C program
- Compilation and execution process
- Writing, compiling, and running a simple C program

1.2 Data Types and Variables (2 hours)

- Basic data types: int, float, double, char
- Type modifiers: signed, unsigned, short, long
- Variable declaration and initialization
- Constants and literals
- Input/output functions: printf(), scanf()

1.3 Operators and Expressions (2 hours)

- Arithmetic operators
- Relational and logical operators
- Assignment operators
- Increment and decrement operators
- Bitwise operators
- Conditional (ternary) operator
- Operator precedence and associativity

1.4 Control Structures (5 hours)

- Decision making: if, if-else, nested if-else, else-if ladder
- Switch-case statement
- Looping constructs: for, while, do-while
- Nested loops
- Break, continue, and goto statements

UNIT 2: Functions and Storage Classes (10 hours)

2.1 Functions (4 hours)
- Introduction to functions and modular programming
- Function declaration, definition, and calling
- Function arguments and return values
- Call by value and call by reference
- Function prototypes
- Library functions vs. user-defined functions

2.2 Recursion (3 hours)
- Concept of recursion
- Recursive vs. iterative approach
- Applications: factorial, Fibonacci series, Tower of Hanoi
- Advantages and limitations of recursion

2.3 Storage Classes (2 hours)
- Automatic (auto) storage class
- External (extern) storage class
- Static storage class
- Register storage class
- Scope and lifetime of variables

2.4 Arrays (1 hour)
- Introduction to arrays
- One-dimensional arrays: declaration, initialization, and accessing
- Basic array operations

UNIT 3: Advanced Topics (10 hours)

3.1 Multidimensional Arrays (3 hours)
- Two-dimensional arrays
- Matrix operations: addition, multiplication, transpose
- Multidimensional arrays
- Passing arrays to functions

3.2 Strings (2 hours)
- String declaration and initialization
- String input/output functions
- String manipulation functions: strlen(), strcpy(), strcat(), strcmp()
- Array of strings

3.3 Pointers (3 hours)
- Introduction to pointers and memory addressing
- Pointer declaration and initialization
- Pointer operators: * (indirection) and & (address-of)
- Pointer arithmetic
- Pointers and arrays
- Pointers and functions
- Pointer to pointer

3.4 Structures (2 hours)
- Introduction to structures
- Structure declaration and initialization
- Accessing structure members
- Array of structures
- Structures and functions
- Nested structures

- Pointers to structures

UNIT 4: Introduction to C++ and Object-Oriented Programming (9 hours)

4.1 Basics of C++ (2 hours)

- Evolution of C++ and comparison with C
- Object-oriented programming concepts: encapsulation, abstraction, polymorphism, inheritance
- Structure of a C++ program
- Basic input/output: cin, cout, cerr
- Namespace and scope resolution operator
- Reference variables and const keyword
- Inline functions and function overloading

4.2 Classes and Objects (3 hours)

- Introduction to classes and objects
- Class declaration and definition
- Access specifiers: private, public, protected
- Member functions and data members
- Creating and accessing objects
- Constructors: default, parameterized, copy constructor
- Destructors
- Static members and friend functions
- this pointer

4.3 Operator Overloading (2 hours)

- Concept of operator overloading
- Overloading unary operators
- Overloading binary operators
- Rules and restrictions for operator overloading
- Type conversion in C++

4.4 Inheritance (2 hours)

- Concept of inheritance and code reusability
- Types of inheritance: single, multiple, multilevel, hierarchical, hybrid
- Base class and derived class
- Access control in inheritance
- Constructor and destructor in derived classes
- Virtual base classes and Function overriding

UNIT 5: Problem-Solving and Practice (10 hours)

This unit focuses on applying the concepts learned in Units 1-4 through hands-on problem-solving on the LeetCode platform. Students will work through 20 carefully selected problems that progressively build problem-solving skills and reinforce programming concepts.

Learning Objectives:

- Apply data structures (arrays, strings, pointers, structures) to solve real problems
- Implement algorithms using control structures and functions
- Develop recursive solutions and understand their applications
- Practice object-oriented programming principles in C++
- Analyze time and space complexity of solutions
- Build debugging and testing skills

Textbooks

1. Kernighan, B. W., & Ritchie, D. M. (1988). The C Programming Language (2nd ed.). Prentice Hall.
2. Balagurusamy, E. (2019). Programming in ANSI C (8th ed.). McGraw Hill Education.
3. Kanetkar, Y. (2020). Let Us C (17th ed.). BPB Publications.
4. Balagurusamy, E. (2017). Object-Oriented Programming with C++ (7th ed.). McGraw Hill Education.
5. Lafore, R. (2002). Object-Oriented Programming in C++ (4th ed.). Pearson Education.
6. Stroustrup, B. (2013). The C++ Programming Language (4th ed.). Addison-Wesley.

Online Resources for Problem Solving:

7. LeetCode Platform - https://leetcode.com/
8. GeeksforGeeks - Data Structures and Algorithms tutorials
9. HackerRank - Programming challenges and competitions

Reference Books

10. Gottfried, B. S. (2010). Programming with C (3rd ed.). Tata McGraw Hill.
11. Forouzan, B. A., &Gilberg, R. F. (2007). Computer Science: A Structured Programming Approach Using C (3rd ed.). Cengage Learning.
12. Deitel, P., &Deitel, H. (2015). C: How to Program (8th ed.). Pearson.
13. Deitel, P., &Deitel, H. (2016). C++ How to Program (10th ed.). Pearson.
14. Lippman, S. B., Lajoie, J., & Moo, B. E. (2012). C++ Primer (5th ed.). Addison-Wesley.
15. Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2009). Introduction to Algorithms (3rd ed.). MIT Press.

Course Outcome Mapping Matrix

CO	Description	Bloom's Level	Units Covered
CO1	Apply fundamental programming constructs	L3 (Apply)	Unit 1, Unit 2
CO2	Analyze and design solutions using advanced data structures	L4 (Analyze)	Unit 2, Unit 3
CO3	Evaluate and optimize program performance	L5 (Evaluate)	Unit 2, Unit 3
CO4	Design and develop object-oriented solutions using C++	L5 (Evaluate)	Unit 4

Unit-wise Course Outcome Mapping

Unit	Mapped COs
Unit 1: Fundamentals of C Programming	CO1
Unit 2: Functions and Storage Classes	CO1, CO2, CO3
Unit 3: Advanced Data Structures	CO2, CO3
Unit 4: Introduction to C++ and OOP	CO4

Assessment Pattern

Assessment Component	Weightage

Continuous Assessment (Quizzes, Assignments)	20%
Mid-Semester Examination	30%
End-Semester Examination	50%

Unit-wise Hour Distribution Summary

Unit	Teaching Hours
Unit 1: Fundamentals of C Programming	10
Unit 2: Functions and Storage Classes	10
Unit 3: Advanced Data Structures	10
Unit 4: Introduction to C++ and OOP	10
Unit 5: Problem-Solving and Practice	10-12
Total	52

LeetCode Problem Set (20 Problems):

The following problems are organized by difficulty and topic. Students should attempt these problems in sequence, starting with easier problems and progressing to more challenging ones.

Beginner Level Problems (Problems 1-8):

1. Two Sum - Find two numbers in an array that add up to a target value.

Link: https://leetcode.com/problems/two-sum/

Concepts: Arrays, Hash Tables

2. Palindrome Number - Determine if an integer is a palindrome.

Link: https://leetcode.com/problems/palindrome-number/

Concepts: Math, Type Conversion

3. Reverse String - Reverse a string in-place using two pointers.

Link: https://leetcode.com/problems/reverse-string/

Concepts: Strings, Two Pointers

4. Fibonacci Number - Calculate the nth Fibonacci number using recursion.

Link: https://leetcode.com/problems/fibonacci-number/

Concepts: Recursion, Dynamic Programming

5. Valid Palindrome - Check if a string is a palindrome considering only alphanumeric characters.

Link: https://leetcode.com/problems/valid-palindrome/

Concepts: Strings, Two Pointers

6. Remove Duplicates from Sorted Array - Remove duplicates in-place from a sorted array.

Link: https://leetcode.com/problems/remove-duplicates-from-sorted-array/

Concepts: Arrays, Two Pointers

7. Contains Duplicate - Check if an array contains any duplicate values.

Link: https://leetcode.com/problems/contains-duplicate/

Concepts: Arrays, Hash Tables

8. Move Zeroes - Move all zeros to the end of array while maintaining order.

Link: https://leetcode.com/problems/move-zeroes/

Concepts: Arrays, Two Pointers

Intermediate Level Problems (Problems 9-13):

9. Binary Search - Implement binary search algorithm on a sorted array.

Link: https://leetcode.com/problems/binary-search/

Concepts: Binary Search, Algorithms

10. Merge Sorted Array - Merge two sorted arrays into one sorted array.

Link: https://leetcode.com/problems/merge-sorted-array/

Concepts: Arrays, Two Pointers, Sorting

11. Maximum Subarray - Find the contiguous subarray with the largest sum (Kadane's Algorithm).

Link: https://leetcode.com/problems/maximum-subarray/

Concepts: Arrays, Dynamic Programming

12. Transpose Matrix - Transpose a given 2D matrix.

Link: https://leetcode.com/problems/transpose-matrix/

Concepts: Multidimensional Arrays, Matrix Operations

13. Find Peak Element - Find a peak element in an array where element is greater than neighbors.

Link: https://leetcode.com/problems/find-peak-element/

Concepts: Arrays, Binary Search

Advanced Level Problems (Problems 14-17):

14. Search in Rotated Sorted Array - Search for a target in a rotated sorted array using modified binary search.

Link: https://leetcode.com/problems/search-in-rotated-sorted-array/

Concepts: Arrays, Binary Search, Algorithms

15. Two Sum II - Input Array is Sorted - Find two numbers that add up to target in a sorted array using two pointers.

Link: https://leetcode.com/problems/two-sum-ii-input-array-is-sorted/

Concepts: Arrays, Two Pointers, Binary Search

16. Find Minimum in Rotated Sorted Array - Find the minimum element in a rotated sorted array.

Link: https://leetcode.com/problems/find-minimum-in-rotated-sorted-array/

Concepts: Arrays, Binary Search

17. Median of Two Sorted Arrays - Find the median of two sorted arrays efficiently.

Link: https://leetcode.com/problems/median-of-two-sorted-arrays/

Concepts: Arrays, Binary Search, Divide and Conquer

Lab Implementation Guidelines:

- Students should attempt 2-3 problems per theory session
- Start with beginner problems and progress to advanced ones
- Write solutions in both C and C++ where applicable
- Focus on understanding multiple approaches to solve each problem
- Analyze time and space complexity of solutions
- Participate in code reviews and discuss alternative solutions

Course Code	Course Title				Category
26ES03TP0103	**Fundamentals of Programming- Lab**				**ESC**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	**2**	**1**	**50**	**00**	**01**

Prerequisite:

Course Objectives:

After completing this course, students will be able to:

Develop fundamental programming skills using C and C++ languages, Understand, basic data structures and algorithms, Learn structured and object-oriented programming concepts, Build problem-solving capabilities through programming exercises, Apply learned concepts to solve real-world coding problems

Course Outcomes:

After successful completion of the course, students will be able to:

CO1: Apply fundamental programming constructs and control structures.
CO2: Implement modular programs using functions, data structures, and algorithms.
CO3: Analyze and evaluate program correctness through systematic testing and debugging.
CO4: Design object-oriented solutions using C++ principles
CO5: Design concepts to solve real-world coding problems.

LABORATORY PRACTICAL MANUAL
FUNDAMENTALS OF PROGRAMMING
B.Tech UG Mechanical Engineering
First Semester

Course Title	Fundamentals of Programming
Credits/Technology	1 [C, C++, Visual Studio Code] [2 hrs/week]
Lab Sessions	10 Practicals (2 hours each)

Introduction

This laboratory manual contains 10 practical exercises designed to reinforce the theoretical concepts covered in Units 1-4 of the C & C++ Programming course. Each practical is structured to provide hands-on experience with programming concepts, data structures, and problem-solving techniques.

Students are expected to complete each practical within the allocated lab session, write well-documented code, test their programs with various inputs, and submit their work as per the instructor's guidelines.

Practical 1: Introduction to C Programming and Basic I/O

Aim:

To familiarize with C programming environment, write a simple C program, and understand basic input/output operations.

Objectives:

- Understand the structure of a C program
- Learn to use printf() and scanf() functions
- Understand data types and variable declarations
- Perform basic arithmetic operations

Problem Statement:

Write a C program that accepts two numbers from the user, performs all arithmetic operations (addition, subtraction, multiplication, division, and modulus), and displays the results with appropriate labels.

Expected Outcomes:

- Students will be able to write, compile, and execute a C program
- Students will understand variable declaration and initialization
- Students will be able to use printf() and scanf() for I/O operations
- Students will understand basic arithmetic operators

Practical 2: Control Structures - Decision Making

Aim:

To implement decision-making constructs in C programming using if-else, nested if-else, and switch-case statements.

Objectives:

- Understand conditional statements and their syntax
- Learn to use relational and logical operators
- Implement nested conditions for complex logic
- Understand switch-case statements

Problem Statement:

Write a C program to create a simple calculator that accepts two numbers and an operator (+, -, *, /, %) from the user. Use switch-case to perform the operation and display the result. Also, implement a grade calculator that accepts marks and displays the grade (A, B, C, D, F) using if-else statements.

Expected Outcomes:

- Students will be able to implement conditional logic
- Students will understand when to use switch-case vs if-else
- Students will be able to handle multiple conditions
- Students will learn input validation techniques

Practical 3: Looping Constructs and Pattern Printing

Aim:

To understand and implement various looping constructs (for, while, do-while) and create pattern-printing programs.

Objectives:

- Understand different types of loops and their applications
- Learn nested loops for complex patterns

- Use break and continue statements
- Develop logical thinking through pattern problems

Problem Statement:
Write C programs to: (a) Print the Fibonacci series up to n terms, (b) Check if a number is prime, (c) Print a pyramid pattern of stars with n rows, (d) Calculate the factorial of a number using different loop types.

Expected Outcomes:
- Students will be able to choose appropriate loop constructs
- Students will understand loop control mechanisms
- Students will develop pattern recognition and logic building skills
- Students will be able to implement nested loops effectively

Practical 4: Functions and Modular Programming
Aim:
To understand function declaration, definition, and calling mechanisms. Implement modular programming using user-defined functions.

Objectives:
- Learn to create and use user-defined functions
- Understand function prototypes and their importance
- Implement functions with different return types and parameters
- Understand call by value mechanism

Problem Statement:
Create a menu-driven program with functions to: (a) Find the largest of three numbers, (b) Check if a number is Armstrong number, (c) Calculate nCr (combination), (d) Convert decimal to binary. Use function prototypes and implement each operation as a separate function.
Expected Outcomes:
- Students will be able to write modular and reusable code
- Students will understand the scope and lifetime of variables
- Students will be able to pass arguments to functions
- Students will understand return values and their usage

Practical 5: Recursion and Its Applications
Aim:
To understand recursive functions and implement recursive solutions for mathematical and computational problems.

Objectives:
- Understand the concept of recursion
- Learn to identify base cases and recursive cases
- Compare recursive and iterative approaches
- Understand stack overflow and recursion depth

Problem Statement:
Write recursive functions to: (a) Calculate factorial of a number, (b) Generate Fibonacci series, (c) Solve Tower of Hanoi problem, (d) Find GCD of two numbers using Euclidean algorithm. Compare execution time with iterative versions for factorial and Fibonacci.

Expected Outcomes:
- Students will be able to design recursive solutions

- Students will understand recursion mechanics and call stack
- Students will be able to trace recursive function calls
- Students will learn when to use recursion vs iteration

Practical 6: Arrays and Array Operations

Aim:

To understand one-dimensional and two-dimensional arrays, and implement various array operations and algorithms.

Objectives:

- Learn array declaration, initialization, and accessing
- Implement searching and sorting algorithms
- Work with two-dimensional arrays for matrix operations
- Pass arrays to functions

Problem Statement:

Write C programs to: (a) Find the largest and smallest elements in an array, (b) Implement linear search and binary search, (c) Sort an array using bubble sort, (d) Perform matrix addition and multiplication for two matrices, (e) Find the transpose of a matrix.

Expected Outcomes:

- Students will be able to manipulate arrays efficiently
- Students will understand array indexing and bounds
- Students will implement basic searching and sorting algorithms
- Students will be able to work with multidimensional arrays

Practical 7: String Manipulation

Aim:

To understand string handling in C and implement various string operations using both library functions and custom functions.

Objectives:

- Understand strings as character arrays
- Learn string library functions (strlen, strcpy, strcat, strcmp)
- Implement custom string functions
- Work with array of strings

Problem Statement:

Write C programs to: (a) Find the length of a string without using strlen(), (b) Copy one string to another without using strcpy(), (c) Concatenate two strings without using strcat(), (d) Check if a string is palindrome, (e) Count vowels and consonants in a string, (f) Sort an array of strings alphabetically.

Expected Outcomes:

- Students will be able to manipulate strings effectively
- Students will understand null termination in strings
- Students will be able to implement string algorithms
- Students will learn to use both library and custom functions

Practical 8: Pointers and Dynamic Memory
Aim:
To understand pointer concepts, pointer arithmetic, and their applications in C programming.

Objectives:
- Understand pointer declaration and initialization
- Learn pointer arithmetic and dereferencing
- Implement call by reference using pointers
- Understand pointers and arrays relationship

Problem Statement:
Write C programs to: (a) Swap two numbers using pointers (call by reference), (b) Find the largest element in an array using pointers, (c) Reverse an array using pointers, (d) Implement a function to sort an array using pointers, (e) Demonstrate pointer to pointer concept with examples.

Expected Outcomes:
- Students will understand memory addressing and pointers
- Students will be able to use pointers for efficient programming
- Students will understand call by reference mechanism
- Students will be able to manipulate arrays using pointers

Practical 9: Structures and User-Defined Data Types
Aim:
To understand structures and implement programs using structures to organize complex data.

Objectives:
- Learn to declare and initialize structures
- Understand structure members and accessing methods
- Work with array of structures
- Pass structures to functions and use pointers to structures

Problem Statement:
Create a student management system using structures that: (a) Stores information of n students (roll number, name, marks in 3 subjects), (b) Calculates total and percentage for each student, (c) Finds the student with highest percentage, (d) Sorts students by roll number, (e) Searches for a student by name. Use array of structures and appropriate functions.
Expected Outcomes:
- Students will be able to design and use structures
- Students will understand how to organize related data
- Students will be able to work with complex data structures
- Students will learn to pass structures to functions

Practical 10: Object-Oriented Programming with C++
Aim:
To understand the basics of C++ and implement object-oriented programming concepts including classes, objects, constructors, and inheritance.

Objectives:
- Understand class and object concepts
- Learn to use constructors and destructors
- Implement inheritance and polymorphism
- Understand access specifiers and encapsulation

Problem Statement:
Create a C++ program for a bank account management system: (a) Define a class Account with data members (account number, name, balance) and member functions (deposit, withdraw, display), (b) Implement constructors (default and parameterized) and destructor, (c) Create a derived class SavingsAccount that inherits from Account and adds interest calculation, (d) Demonstrate operator overloading by overloading + operator to transfer amount between accounts.

Expected Outcomes:
- Students will be able to design classes and create objects
- Students will understand OOP principles (encapsulation, inheritance)
- Students will be able to implement constructors and destructors
- Students will learn operator overloading and inheritance

Laboratory Course Outcomes

CO1: Apply fundamental programming constructs and control structures
- **Bloom's Level:** L3 (Apply)
- **Covers Original Outcomes:** 1, 2
- **Statement:** Apply fundamental C programming constructs including data types, operators, and control structures to write, compile, debug, and execute programs that solve computational problems.

CO2: Implement modular programs using functions, data structures, and algorithms
- **Bloom's Level:** L3 (Apply)
- **Covers Original Outcomes:** 3, 4, 5, 6
- **Statement:** Implement modular programs using functions, recursion, arrays, strings, pointers, and structures while applying searching and sorting algorithms with proper memory management.

CO3: Analyze and evaluate program correctness through systematic testing and debugging
- **Bloom's Level:** L4 (Analyze)
- **Covers Original Outcomes:** 8, 9, 10
- **Statement:**Analyze computational problems, design algorithms, and systematically test and debug programs to ensure correctness while developing problem-solving and computational thinking skills.

CO4: Design object-oriented solutions using C++ principles
- **Bloom's Level:** L6 (Create)
- **Covers Original Outcomes:** 7
- **Statement:** Design and develop object-oriented programs in C++ using classes, objects, and inheritance to create reusable and efficient solutions.

Laboratory Guidelines

Instructions for Students:
- Come prepared to the lab with prior understanding of the practical topic
- Write clean, well-commented, and properly indented code
- Test your programs with multiple test cases including edge cases
- Maintain a lab record/journal documenting all practicals
- Follow proper variable naming conventions and coding standards
- Debug errors systematically and seek help when stuck
- Submit assignments on time as per instructor guidelines

Assessment Criteria:

Component	Marks	Description
Program Logic & Algorithm	40	Correctness and efficiency
Code Quality & Documentation	20	Comments, formatting
Execution & Output	30	Error-free execution
Viva & Understanding	10	Concept clarity
Total	**100**	

References

Textbooks:

1. Kernighan, B. W., & Ritchie, D. M. (1988). The C Programming Language (2nd ed.). Prentice Hall.
2. Balagurusamy, E. (2019). Programming in ANSI C (8th ed.). McGraw Hill Education.
3. Kanetkar, Y. (2020). Let Us C (17th ed.). BPB Publications.
4. Balagurusamy, E. (2017). Object-Oriented Programming with C++ (7th ed.). McGraw Hill Education.

Reference Books:

5. Gottfried, B. S. (2010). Programming with C (3rd ed.). Tata McGraw Hill.
6. Deitel, P., &Deitel, H. (2015). C: How to Program (8th ed.). Pearson.
7. Lafore, R. (2002). Object-Oriented Programming in C++ (4th ed.). Pearson Education.
8. Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2009). Introduction to Algorithms (3rd ed.). MIT Press.

Online Resources:

- GeeksforGeeks - C Programming tutorials and examples
- TutorialsPoint - C and C++ programming guides
- cppreference.com - C and C++ language reference
- LeetCode - Programming practice problems
- W3schools

Textbooks:

1. Kernighan, B. W., & Ritchie, D. M. (1988). The C Programming Language (2nd ed.). Prentice Hall.
2. Balagurusamy, E. (2019). Programming in ANSI C (8th ed.). McGraw Hill Education.
3. Kanetkar, Y. (2020). Let Us C (17th ed.). BPB Publications.
4. Balagurusamy, E. (2017). Object-Oriented Programming with C++ (7th ed.). McGraw Hill Education.

Reference Books:

1. Gottfried, B. S. (2010). Programming with C (3rd ed.). Tata McGraw Hill.
2. Deitel, P., & Deitel, H. (2015). C: How to Program (8th ed.). Pearson.
3. Lafore, R. (2002). Object-Oriented Programming in C++ (4th ed.). Pearson Education.
4. Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2009). Introduction to Algorithms (3rd ed.). MIT Press.

Online Resources:

1. GeeksforGeeks - C Programming tutorials and examples

2. TutorialsPoint - C and C++ programming guides
3. cppreference.com - C and C++ language reference
4. LeetCode - Programming practice problems

Course Code	Course Title				Category
26HS02TP0101	**Foundations of Business English**				**AEC/ HSSM**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
2	**2**	**0**	**50 +25**	**50 +25**	**3**

Prerequisite:

Course Objectives:
The course aims to develop foundational communication skills required for academic and professional success by enhancing students' competence in grammar, vocabulary, speaking, listening, reading, and writing. It also seeks to familiarize learners with workplace communication practices and emerging AI-assisted communication tools, thereby improving their employability and readiness for professional contexts.

Course outcomes:
On successful completion of the course, the students will be able to achieve the following:
CO1: Apply and demonstrate active listening techniques and grammatical rules to construct accurate, coherent, and contextually appropriate communication.
CO2: Analyse and apply verbal aptitude strategies, business vocabulary, and reading comprehension techniques to interpret written communication effectively.
CO3: Demonstrate and adapt public speaking techniques and professional etiquette to deliver structured and audience-centric oral communication in workplace scenarios.
CO4: Evaluate and apply employability communication strategies by actively participating in group discussions, mock interviews, and résumé-building exercises to meet professional standards.
CO5: Create and justify professional documents using appropriate formats and ethically integrate AI-assisted tools to enhance clarity, accuracy, and effectiveness in communication.

UNIT I: Listening Comprehension and Remedial Grammar	**05 Hours**
Listening Comprehension: Active listening, Reasons for poor listening, Barriers to effective listening, Traits of a good listener, Note-making Remedial Grammar: Common Errors in Indian English, Subject-verb agreement, Tenses	
UNIT II: Structural Communication and Reading Comprehension	**05 Hours**
Verbal Aptitude: Para-jumbles, Analogies, Sentence completion, Syllogisms Business Vocabulary: Use of power verbs, power adjectives and power adverbs, Common technical affixes, avoiding corporate jargons Reading Comprehension: Types and Strategies	
UNIT III: Speaking Skills	**05 Hours**
Public Speaking: Mechanics of Public Speaking, Five-C model of storytelling (audience-centric), principles of effective introductions and welcome addresses, and questioning techniques. Professional Oral Communication: Meetings, Seeking and giving feedback, Professional Etiquette: greetings, introductions, politeness strategies, telephone and virtual communication	
UNIT IV: Communication for Employment	**05 Hours**

Group Discussions: concepts, types, roles, and evaluation parameters Résumé Building: structure, content, and formatting techniques Introduction to Interview Skills: types of interviews, commonly asked questions, and response strategies

UNIT V: Professional Communication	**06 Hours**

Principles of professional document design Academic and professional email writing (format, tone, etiquette) Instruction writing (clarity, sequencing, audience awareness) Statement of Purpose (SOP): structure and content Introduction to AI-assisted communication (AI prompts and applications) and Ethical considerations in the use of AI in professional communication

BOOKS:

1. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
2. Practical English Usage. Michael Swan. OUP. 1995.
3. Remedial English Grammar. F.T. Wood. Macmillan.2007
4.On Writing Well. William Zinsser. Harper Resource Book. 2001
5.Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
6.The AI Prompt Handbook for Business Writing: 50+ Prompts for Professionals, Managers & Entrepreneurs (The AI Prompt Handbook Series), Maxwell Striling, 2026

Foundations of Business English Lab

List of Practical

Computer Assisted + Activity Based Language Learning

Practical 1: Everyday Situations: Conversations and Dialogues – Listening Skills
Practical 2: Reading Skills
Practical 3: Everyday Situations: Conversations and Dialogues – Speaking Skills
Practical 4: Pronunciation, Intonation, Stress, and Rhythm

Activity Based Language Learning

Practical 5: Public Speaking
Practical 6: Presentation Skills: Orientation
Practical 7: Presentation Skills: Mock
Practical 8: Group Discussions: Practice
Practical 9: Group Discussions: Mock

Course Code	**Course Title**				**Category**
26HS02TH0103-2	**Foundational Course in Universal Human Values**				**VEC/ HSSM**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
1	**0**	**0**	**50**	**-**	**1**

Prerequisite:

Course Objectives:

To help the students in holistic development and maintaining harmony at all the levels of a human being, i.e. individual, family, society and nature/existence.

Course outcome: On completion of course, students will be able to achieve the following:

CO1**:** Understand value education in life and implement self-exploration.
CO2: Create an in-depth understanding of harmony within a human being.
CO3: Understand and implement values to maintain harmony in a family.

CO4: Understand and implement values to maintain harmony in a society
CO5: Understand and implement values to maintain harmony in nature/existence and develop a holistic perspective of life.

UNIT I: Course Introduction - Understanding Value Education	**4 Hours**

1.Meaning of Value Education
2.Need of value education, guidelines and content of value education.
3.Exploring our aspirations and concerns: Self-exploration (Content and process of self-exploration)
4. Basic human aspirations: Continuous happiness and prosperity
5. Role of UHV; Strengthening of self-reflection.

UNIT II: Understanding Harmony in Human Being	**3 Hours**

1.Harmony of the self and the body.
a. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
b. Understanding the needs of Self ('I') and 'Body' .
c. Understanding the activities of Self ('I') and 'Body'
d. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer).
2. Programs to ensure Sanyam and Health.

UNIT III: Understanding Harmony in the Family: Harmony in Human-Human relationship	**3 Hours**

1. Understanding values in human-human relationship:
a.Trust as the foundational value of a relationship and respect in a family
b.Ensuring health of family and friends by implementing values
c.Understanding the meaning of trust;
d.Difference between intention and competence
e.Understanding the meaning of respect,
f.Difference between respect and differentiation

UNIT IV Understanding harmony in the society: Harmony in Human-Human relationship	**2 Hours**

1.Understanding harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust)
2.Visualizing a universal harmonious order in society: Undivided Society, Universal Order-from family to world family.

UNIT V Understanding Harmony in Nature and Existence:	**3 Hours**

1. Understanding harmony in Nature
2. Interconnectedness and mutual fulfilment among the four orders of Nature
3. Holistic perception of harmony at all the levels of existence

TEXT BOOK:
1.A Foundation Course in Human Values and Professional Ethics, R.R Gaur, R Athana, G.P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019, ISBN 948-93-87034-47-1
2.A Textbook on Professional Ethics and Human Values by R S Naagarazan, New Age International Private Limited; First edition, 2020.

Reference Books:
1. Human Values, A.N. Tripathi, Human Values, New Age Intl. Publishers, New Delhi, 2004.
2. Human Values and Professional Ethics by Gurpreet Singh Uppal, 2015.

3. Values and Ethics in Profession by Prof. Mazumdar, Everest Publishing House; 3rd Edition, 2013.
4. Human Values and Professional Ethics by Jayshree Suresh, B S Raghavan, S Chand; Fourth edition, 2003.
5. https://fdp-si.aicte-india.org/UHV-II_Lectures_PPTs.php
6. dp-si.aicte-india.org/UHV-II%20Practice%20Sessions.php
7. https://fdp-si.aicte-india.org/UHV-II%20Class%20Note.php
8. B L Bajpai, 2004, *Indian Ethos and Modern Management*, New Royal Book Co., Lucknow. Reprinted 2008
9. PL Dhar, RR Gaur, 1990, *Science and Humanism*, Commonwealth Purblishers.
10. Sussan George, 1976, *How the Other Half Dies,* Penguin Press. Reprinted 1986, 1991
11. Ivan Illich, 1974, *Energy & Equity,* The Trinity Press, Worcester, and HarperCollins, USA
12. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, limits to Growth, Club of Rome's Report, Universe Books.
13. Subhas Palekar, 2000, *How to practice Natural Farming,* Pracheen(Vaidik) Krishi Tantra Shodh, Amravati.
14. A Nagraj, 1998, *Jeevan Vidya ek Parichay,* Divya Path Sansthan, Amarkantak.
15. E.F. Schumacher, 1973, *Small is Beautiful: a study of economics as if people mattered*, Blond & Briggs, Britain.

Syllabus Semester-II

Course Code	Course Title				Category
26HS03TH0217	**Engineering Mathematics II**				**BSC**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	**0**	**1**	**50**	**50**	**03**

Prerequisite: Students should possess basic knowledge of Mathematics, including algebra, trigonometry, and elementary calculus.

Course Objectives:
The objective of this course is to familiarize the prospective engineers with techniques in Calculus and multivariate analysis. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

Course Outcomes:
On successful completion of the course, the students will able to:
1. Interpret the solutions of system of linear equations and use the concepts of Eigen values, Eigen vectors to find diagonalization of matrices.
2. Evaluate definite and improper integrals using Beta, Gamma functions, and trace the Cartesian curves.
3. Solve multiple integration by change of order, change of variable methods and apply it

to find area, volume, mass and center of gravity.
4 Interpret the geometrical meaning of gradient, curl, divergence.
5. Perform line, surface and volume integrals of vector-valued functions.

UNIT I: Linear Algebra	**7 Hours**

Rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Eigenvalues and eigenvectors; Diagonalization of matrices; Orthogonal transformation and quadratic to canonical forms, Introduction to n-dimensional space, Singular value decomposition and its application in reducing the dimensionality of images and data.

UNIT II: Integral Calculus	**7Hours**

Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Tracing of curves(Cartesian form)

UNIT III: Multiple Integral	**8 Hours**

Multiple Integration: Double and triple integrals (Cartesian and polar), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: area, mass and volume by double integration, Center of mass and Gravity (basic concepts).

UNIT IV: Vector Calculus (Differentiation	**7 Hours**

Scalar point function, Vector point function, vector differentiation, gradient, divergence and curl, directional derivatives with their physical interpretations, solenoidal and irrotational motions, Scalarpotential function.

Unit V: Vector Calculus (Integration)	**7 Hours**

Vector integration: Line integrals, work done, conservative fields, surface integrals and volume integrals, Stoke's theorem, Gauss divergence theorem, Green's theorem and their simple applications.

Textbooks

1**.** B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

References

1. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
2.Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. P. N. Wartikar and J. N. Wartikar, A text book of Applied Mathematics Volume I & II, Pune VidhyarthiGrihaPrakashan, Pune-411030 (India).

Course Code	**Course Title**				**Category**
26HS05TP0203	**Applied Physics**				**BSE**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	**02**	**02**	**50**	**50**	**4**

Prerequisites:

Course Objectives:

After completing this course, students will be able to:

1. To develop ability to correlate basic physics principles involved in Robotic operations.
2. To help to improve fundamental robotic operations.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Use LASER beam and its various applications.
2. Apply knowledge of Ultrasonics for robotic operations.
3. Study and apply fundamental principles of electromagnetics to Mechanical Engineering.
4. Apply fundamental knowledge of fluid dynamics to underwater and arial robotics. Explore various sensing mechanisms pertaining to various Robotic operations.
5. Prepare for measurements used in various experiments and analyze errors involved in the measurements and prepare reports.

Explore various methods for finding wavelength of light, magnetic field intensity, speed of waves.

UNIT I: Laser Physics	**08 Hrs.**

Basics of Laser light emission: Spontaneous and stimulated emission of radiations, thermal equilibrium, condition for light amplification, population inversion, pumping schemes, optical resonator, He-Ne Laser/ Ruby Laser.

Laser beam characteristics: Monochromaticity, Coherence, Directionality, Focusibility, Intensity, Beam divergence and applications thereof.

UNIT II: Ultrasonics	**08 Hrs.**

Basics of Ultrasonics: Ultrasonic waves, production and detection of ultrasonic waves, piezoelectric effect, properties and types of ultrasonic waves, measurement of ultrasonic velocity in liquids.

Applications of Ultrasonic waves: in the measurement of elastic constants in liquids, application of ultrasonic waves in drilling, welding, soldering, in non-destructive testing of various materials, in generating 3D maps.

UNIT III: Electromagnetism	**08 Hrs.**

Magneto-statics: Lorenz Force, Biot-Savart and Ampere's Laws and their applications, Magnetic vector potential, force and torque on a magnetic dipole, and applications.

Electrodynamics: Ohms law, motional emf, Faraday's law, Lenz's law, Mutual induction, energy storage in magnetic fields, Maxwell's equations and applications.

UNIT IV: Aeronautics Physics	**08 Hrs.**

Fluid mechanics for underwater and aerial robotics. Buoyancy, floatation, stability of floating body. Hydro-dynamics: Boundary layer concepts of drag, lift, its real-world applications to smart skies, mobile accelerometers, parachutes, helicopters, numerical on drag & lift forces, parachute design.

UNIT V: Sensors and Actuators	**08 Hrs.**

Design and working principles of Sensors. Various types of Sensors requited for Robotics: Strain, pressure, ultrasonic, piezoelectric, chemical, thermal, optical, electrical, etc, as required for various types of detection.

TEXT BOOKS:

1. Engineering Electromagnetics, Sixth Edition, William H. Hayt, John A. Buck,

McGraw-Hill Higher Education, 2001.
2. Applied Physics by S. Jain, G. G. Sahasrabudhe and S. M. Pande, Universities Press 2013.

REFERENCE BOOKS:

1. Ultrasonics: Fundamentals, Technologies, and Applications, Dale Ensminger, Leonard J. J. Bond. 2011, CRC press, 2011.
2. Fundamentals of Aerodynamics 5ED (SIE), McGraw Hill Education, 2017.
3. Fundamentals of Sensors for Engineering and Science (English, Paperback, Dunn Patrick F.), CRC Press, Taylor & Francis Inc, 2011.
4. Engineering Physics by M.N. Avadhanulu and Kshirsagar S. Chand Publication, 2014.

Course Code	Course Title				Category
26ES04TH0201	Theory of Mechanisms & Elasticity				PCC
Contact Hours per Week			CA	FE	Credits
L	P	S			
03	00	01	50	50	3

Prerequisites:

Students should have:

1. Knowledge of **Mathematics**, including algebra, trigonometry, and elementary calculus.
2. Knowledge of Engineering Mechanics course.

Course Objectives:

After completing this course, students will be able to:

1. Understand the fundamentals of mechanisms and machines, including kinematic pairs, chains, and degrees of freedom.
2. Analyze and apply inversions of mechanisms in practical engineering systems and machines.
3. Study the design and motion characteristics of cams and followers used in automated systems.
4. Develop knowledge of stress, strain, and material behavior under different loading conditions.
5. Apply concepts of compound stresses, strain energy, and failure analysis in engineering applications.

Course Outcomes:

After successful completion of the course, students will be able to:

CO1: Explain and analyze mechanisms, kinematic chains, and degrees of freedom using standard criteria such as Kutzbach's and Gruebler's equations.

CO2: Apply the concept of inversions of mechanisms to evaluate and design common machine elements like four-bar chains and slider-crank mechanisms.

CO3: Analyze cam-follower systems, including motion profiles, displacement diagrams, and pressure angle considerations.

CO4; Evaluate simple stresses and strains, including deformation, thermal effects, and stress-strain relationships in materials.

CO5; Analyze compound stress systems and strain energy concepts, including principal

stresses, Mohr's circle, and energy methods for impact loading	
UNIT I: Basics of Mechanisms and Machines	**08 Hrs.**
Basics of Mechanisms and Machines: Basic concept of mechanism, link, kinematics pairs, kinematics chain, mechanism, machine, simple & compound chain, Degree of freedom, Kutzbach's theory, Grubber's criterion. Harding's notations, Class-I& Class-II mechanisms	
UNIT II: Applications of Inversion of Mechanisms	**08 Hrs.**
Inversions and applications of a four-bar chain, single slider crank chain and double slider chain. Limiting positions, Mechanical advantage, Transmission angle, various types of mechanism such as Geneva wheel, Pawl and ratchet mechanism, and mechanism used in various toys, Introduction to Belt drive, Chain drive and gear drives	
UNIT III: Cams and Followers	**08 Hrs.**
Classification of cams and followers-Terminology and definitions- Displacement diagrams-uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions, and pressure angle and its significance, radial follower and offset followers	
UNIT IV: Concept of simple stresses and strains	**08 Hrs.**
Concept of stress and strain, Types of stresses: Direct and tangential stresses, Types of strains: longitudinal, lateral, volumetric, Simple and modified Hooke's Law and elastic constants (E, G, K, μ) Stress-strain diagram (ductile & brittle materials), Factor of safety, Poisson's ration, Deformation of bars under axial load and due to self-weight, Axial force diagram, Thermal stresses and strains.	
UNIT V: Compound Stresses & Strain and Strain Energy	**08 Hrs.**
Compound Stresses & Strain: Stress on inclined plane, Significance of principal stresses and principal planes, maximum shear stresses, Mohr's circle of stress **Strain energy:** Strain energy and resilience, Proof resilience and modulus of resilience, Strain energy in axial, shear, bending, and torsion, Impact and suddenly applied loads	
TEXT BOOKS: 1. Theory of Machines: S.S. Rattan, Tata McGraw Hill Publishers, 3rd edition onwards 2. Strength of Materials by S.S. Rattan, McGraw-Hills Education (India) Publication, India. *3.* Strength of Materials by S.S. Bhavikatti, Vikas Publishing house, Noida, India.	
REFERENCE BOOKS: 1 Deepak Khemani. A First Course in Artificial Intelligence.McGraw Hill Education (India), 2013. Denis Rothman. Artificial Intelligence by Example, Packt, 2018. 2. Kinematics & Dynamics of Machinery: R.L. Norton Tata McGraw Hill Publishers 3. Mechanism and Machine Theory: J.S. Rao&Rao V. Dukkipati, New Age International 4. Strength of Materials by F.L. Singer, Harper and row Publication. 5. Engineering Mechanics of Solid by Egor P. Popov, Prentice Hall of India Publication.	

Course Code	**Course Title**					**Category**
26ES04TP0202	**Machine Drawing and Solid Modelling Sem-II**					PCC
Contact Hours per Week				**CA**	**ESE**	**Credits**
L	**P**	**S**	Credits			

2	2	2	3	50	50	3

Prerequisite: Students must have successfully completed **Engineering Graphics (Drawing)** in the first semester, with foundational knowledge of orthographic and isometric projections.

Course Objectives: The objective of the course is

1: To impart knowledge of Indian Drawing Standards (SP-46) for the conventional representation of machine elements and the application of limits, fits, and tolerances.

2: To develop understanding in creating parametric 3D parts and complex assemblies using geometric modelling software to generate automated Bill of Materials (BOM) and production drawings.

Course Outcomes: After completing this course, students will be able to:

CO1: Classify and select standard machine elements (fasteners, springs, gears) using conventional representations.

CO2: Apply limits, fits, and geometric tolerances to components for functional assembly requirements.

CO3: Develop 3D parametric models of complex machine parts using software Sketcher and Part features.

CO4: Construct virtual assemblies of mechanical systems and generate detailed production drawings.

CO5: Demonstrate readiness for the Industry-linked Certification by solving standard modelling challenges.

Unit I: Drawing Standards & Conventional Representation (4 Hours)

- Indian Drawing Standards (SP-46).
- Conventional representation of standard elements: Bolts, Nuts, Washers, Rivets, Gears, and Springs.
- Representation of Welding and Piping symbols.

Unit II: Limits, Fits, and Tolerances (GATE Focus) (5 Hours)

- Terminology, Types, and Applications of fits (Clearance, Transition, Interference).
- Dimensional and Geometrical Tolerances.
- Calculations of basic fundamental deviations and tolerance zones for simple case.

Unit III: Assembly and Production Drawing Principles (5 Hours)

- Principles of dismantling and assembly; study of standard subassemblies of 2 parts.
- Preparation of Full Assembly drawings and Production drawings for 2-3 parts.
- Preparation of **Bill of Materials (BOM)** and part list nomenclature.

Unit IV: Goemetric modeling of a simple machine component (5 Hours Theory + 12 Hours Lab)

- **Sketcher:** Sketch entities and constraints (geometric and dimensional).
- **Part Modeling:** Extrude, Revolve, Sweep,Fillet and Chamfer.
- Mass properties and material assignment.

Unit V: Parts Assembly & Detailing (5 Hours Theory + 12 Hours Lab)

- **Assembly Modeling:** Mates (Standard, Advanced, and Mechanical).
- Generating 2D views from 3D models: Sectional views, Auxiliary views, and Detailing.
- Preparation for Industry linked certification: Practice on part modeling and assembly clusters.

TEXT BOOKS:

1. Machine Drawing by N. D. Bhatt, Charotar Publications.
2. Machine Drawing by K. L. Narayana, R. Kannaiah, K. V. Reddy, New Age International.
3. Machine Drawing by R. K. Dhawan, S. Chand Publications.
4. Machine Drawing by P. S. Gill, S. K. Kataria & Sons.

REFERENCE BOOKS:

1. Engineering Drawing Practice for Schools & Colleges (SP-46:2003): Bureau of Indian Standards.
2. Production Drawing by K. L. Narayana, New Age International.
3. SOLIDWORKS 2024 for Designers by Prof. Sham Tickoo, CADCIM Technologies.

Course Code	Course Title					Category
26ES04TP0202	**Machine Drawing & Solid Modelling Lab Sem-II**					PCC
Contact Hours per Week				**CA**	**ESE**	**Credits**
L	**P**	**S**	Credits			
0	2	2	1	25	25	1

Prerequisite: Students must have successfully completed **Engineering Graphics (Drawing)** in the first semester, with foundational knowledge of orthographic and isometric projections.

Course Objectives: The objective of the course is

1: To impart knowledge of Indian Drawing Standards (SP-46) for the conventional representation of machine elements and the application of limits, fits, and tolerances.

2: To develop proficiency in creating parametric 3D parts and complex assemblies using geometric modelling software to generate automated Bill of Materials (BOM) and production drawings.

Course Outcomes: After completing this course, students will be able to:

CO1: Classify and select standard machine elements (fasteners, springs, gears) using conventional representations.

CO2: Apply limits, fits, and geometric tolerances to components for functional assembly requirements.

CO3: Develop 3D parametric models of complex machine parts using software Sketcher and Part features.

CO4: Construct virtual assemblies of mechanical systems and generate detailed production drawings.

CO5: Demonstrate readiness for the Industry-linked Certification by solving standard modelling challenges.

List of Experiments

1. Conventional representation, Standard machine elements
2. Sketching, Parts and Assembly,
3. Dismantling & Production drawing.
4. Level 1: Very Easy (Basic Part Modeling-**any one**)
   Screwed fasteners (bolt, nut, washer)
   Keys, Cotter and pin joints, Simple pipe joints, Basic shaft
   Skills: Sketching, Extrude, Revolve, Fillet, Chamfer
5. Level 2: Easy Assemblies (**any one**)
   Shaft couplings (rigid/flange), Bearings (simple representation), Riveted joints, Pipe couplings
   Skills: Assembly mates, concentric alignment, basic motion
6. Level 3: Moderate Machine Elements (**any-one**)
   Gears (spur), Eccentric, Piston, Crosshead, Steam engine connecting rod end
   Skills: Patterns, equations, reference geometry

Course Code			Course Title		Category
26ES04TP0203			**Data Structures**		Professional Core
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
03	02	02	100	50	04

Prerequisite: Programming for Problem Solving

Course Objectives:

1. To introduce the basic concepts of data structures and algorithms.
2. To familiarize students with different searching and sorting techniques.
3. To enable students to use appropriate data structure for solving real-world problems

Course Outcomes:

On successful completion of the module students will be able to:

CO1: Demonstrate understanding of fundamental data organization concepts, abstract data types (ADT), algorithm design principles, and analyze computational efficiency using asymptotic notations, time complexity, and space complexity.

CO2: Apply linear data structures such as arrays, stacks, and queues to design, implement, and solve problems

CO3: Design and implement linked data structures including singly, doubly, and circular linked lists, and perform various operations such as insertion, deletion, traversal etc.

CO4: Analyze and implement hierarchical and network-based data structures including trees, binary search trees, and graphs for efficient searching, balancing, traversal, and representation of complex relationships.

CO5: Evaluate, compare, and implement various sorting and searching techniques

UNIT I: Data Structures and Algorithm Basics	**08 Hrs.**

Introduction: Elementary data organizations and operations on it. Abstract data types (ADT) and their characteristics.

Algorithms: Characteristics, Asymptotic notations, time and space trade-offs, Analysis of algorithm.

Array ADT: Representations – row-major and column-major form, Implementation of problems using arrays.

UNIT II: Linked List	**08 Hrs.**

Singly Linked Lists (SLL): Creation of SLL, Operations on SLL: Insertion, Deletion, Traversal, reversal, ordering, etc., Linked representation of stacks and queues, Header node linked lists.

Doubly and Circular Linked Lists (DLL and CLL): Creation of Linked list and operations on it.

UNIT III: Stacks and Queues	**08 Hrs.**

Stack ADT: Stack implementation using Linked list, Operations on Stack.

Queue ADT: Queue implementation using Linked list, Circular queue, Operations on queue, introduction to double-ended queues and priority queues.

UNIT IV: Trees and Graphs	**08 Hrs.**
Trees: Terminologies, Binary tree and operations, Binary search tree [BST] and operations. Introduction to Graphs: Basic terminologies, representation of graphs, graph traversals: depth first search (DFS) and Breadth first search (BFS).	
UNIT V: Sorting and Searching	**08 Hrs.**
Sorting: Implementation of Shell, quick, merge, heap, counting sort, performance analysis and comparison. **Searching:** Revision of linear search, binary search and complexity analysis of search methods. Hash functions and hash tables, closed and open hashing, randomization methods (division method, mid-square method, folding), collision resolution techniques.	

TEXT BOOKS:

1. Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed; Fundamentals of Data Structures in C; Second Edition; Universities Press; 2008.
2. Robert Kruse, C. L. Tondo, Bruce Leung, Sashu Mogalla, Data Structures and Program Design in C; Second Edition; Pearson Education; 2006.
3. Mark Allen Weiss; Data Structures and Algorithm Analysis in C; Second Edition; Pearson Education; 2002.

REFERENCE BOOKS:

1. Reema Thareja, Data Structures using C, Third Edition, Oxford University Press, 2023

2. Narasimha Karumanchi, Data Structures and Algorithms Made Easy: Data Structures and Algorithmic Puzzles Fifth Edition, Career Monk Publications, 2016.

3. The Complete Reference: Herbert Schildt, 4th (any recent) Edition, Tata McGraw Hill

Data Structures Lab

List of Experiments

1. Write a program to perform basic Array operations – insertion, deletion, traversal, searching, and updating elements.
2. Implement matrix representation using row-major and column-major order for two-dimensional arrays.
3. Create and perform operations on Singly Linked List (SLL) – insertion, deletion, traversal, reversal, and sorting.
4. Implement Doubly Linked List (DLL) and Circular Linked List (CLL) with creation and basic operations.
5. Implement Stack using Linked List and perform push, pop, peek, and display operations.
6. Implement Queue using Linked List and perform enqueue, dequeue, and display operations.
7. Implement Circular Queue, Deque, and Priority Queue for different queue applications.
8. Create Binary Tree and Binary Search Tree (BST) and perform insertion, deletion, searching, and tree traversals.
9. Represent Graph using adjacency matrix/list and perform DFS and BFS traversals.
10. Implement Sorting and Searching techniques – Quick Sort, Merge Sort, Heap Sort, Linear Search, Binary Search, and Hashing with collision resolution.

Course Code	**Course Title**				**Category**
26ES04TP0204	**Fabrication Practices**				PCC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
1	2	1	20	30	2

Prerequisite: Manufacturing Processes.

Course Objectives:
The objective of the course is to prepare the students:
1. Identify the different manufacturing process for various workshop trades including fitting, carpentry, smithy/foundry and welding, etc.
2. To get acquainted with the knowledge of various machine tools and equipment.

Course outcomes:
At the end of this course students will be able to:
1. Understand casting technique for the production of casted components.
2. Identify an appropriate moulding pattern and various carpentry joints.
3. Understand the machining parameters and cutting tool for various machining operations.
4. Distinguishwithhotandcoldworkingmethodforthemanufacturingofmetalcomponents.
5. Understand various fitting joints and sheet metal operations.
6. Apply the knowledge of suitable joining processes to carryout fabrication work.

Foundry and Carpentry	**3 Hrs.**

Introduction to foundries, metal casting, types of sand, introduction to moulding tools & different casting process. Introduction to pattern making for metal casting, different types of carpentry tools, holding devices, different types of carpentry joints.

Metal Cutting	**3 Hrs.**

Fundamentals of metal cutting, Lathe machine specification and operations, metal cutting parameters, single point cutting tool.

Smithy and Forging	**2 Hrs.**

Smithy and forging, hot working and cold working of metals, forging tools like chisels, hammers, types of furnaces.

Fitting	**2 Hrs.**

Fitting operations and associated measuring and marking tools, sheet metal operations. Laser Cuting.

Welding	**2 Hrs.**

Metal joining Process, types of welding, mechanics of welding, soldering and brazing. Robotic welding.

Text Books:

Workshop Technology, Volume-I&II, Hajra Choudhary, Media Promoters & Publishers Pvt. Ltd. Manufacturing Technology, Volume-I&II- P.N.Rao, Tata McGraw Hill Pub. Company, New Delhi.

Reference Books:

Manufacturing Science - A.Ghosh & A.K.Malik – East West Press Pvt. Ltd. New Delhi.

Fabrication Practices Lab

Course Objectives:

The Objective of the course:

1. To familiarize with major manufacturing process and required Machine Tools.
2. To get acquainted with and hands on experience on machine tools and equipments.

Course Outcomes:

The expected learning outcome is that the students will be able to:

1. Prepare and mould for casting and perform pattern making.
2. Perform different machining operations on lathe machine and parts fitting job.
3. Apply the knowledge of joining processes to carry out fabrication work.

List of Experiments:

Introduction of tools, equipments, material & process along with demonstration and preparation of simple job using various workshop trades such as:

1. Metal casting and molding practice
2. Pattern making practice
3. Machining practices
4. Smithy and forging practice
5. Fitting job practice
6. Welding practice

*Case study: To prepare simple model/project using various workshop facilities (Group Activity)

Text Books

1. Workshop Technology, Volume - I & II - By Hajra Choudhary, Media Promoters &Publishers Pvt. Ltd.
2. Manufacturing Technology, Volume - I & II - P.N. Rao, Tata McGraw Hill Pub. Company, New Delhi.
3. Manufacturing Science - A.Ghosh & A.K.Malik – East West Press Pvt. Ltd. New Delhi.

Reference Books

1. Kalpak Jain and Schimd, Manufacturing processes for engineering materials, 5th Edition - Pearson India, 10034.
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and System.
3. Production Engineering - P. C. Sharma, S. Chand and Company Ltd., New Delhi.

Course Code	**Course Title**		**Category**		
26ES03TH0104	**Design Thinking**		AEC		
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**T**	**D/P**			
01		00	50	-	01

Prerequisite: NA

Course Objectives: Be familiar with processes and methods of creative problem solving
Enhance their creative and innovative thinking skills
Practice thinking creatively and innovative design and development.

Course Outcomes: On successful completion of the module students will be able to:
CO1: Explain key concepts, principles, and processes of creativity, innovation, and design thinking.
CO2: Apply design thinking methodologies to identify user needs and define real-world problems.
CO3: Generate and evaluate creative ideas using structured ideation techniques.
CO4: Develop, prototype, and test innovative solutions based on user-centered design.
CO5: Collaborate in teams to communicate ideas effectively and assess solutions for feasibility, viability, and impact.

UNIT I. Introduction: Making a case for creativity, Creative thinking as a skill, Valuing diversity in thinking: Thinking preferences, Creativity styles, Creativity in problem solving	**02Hrs.**
UNIT 2. Pattern Breaking: Thinking differently , Lateral thinking, Mind stimulation: games, brain-twisters and puzzles, Idea-collection processes, Brainstorming/Brain-writing, The SCAMPER methods, Metaphoric thinking, Outrageous thinking , Mapping thoughts, Other (new approaches)	**03 Hrs.**
UNIT 3. Using Math and Science, Systematic logical thinking, Using math concepts, Eight-Dimensional (8D) Approach to Ideation: Uniqueness, Dimensionality, Directionality, Consolidation, Segmentation, Modification, Similarity, Experimentation	**3 Hrs.**
UNIT4. Systematic Inventive Thinking: Systematic inventive thinking: The TRIZ methodology, Decision and Evaluation: Focused thinking framework, Six thinking hats , Ethical considerations	**02 Hrs.**
UNIT 5. Design for Innovation: Introduction to design for interaction, nine lessons for innovation, difference in creativity and innovation, Building blocks for innovation	**02Hrs.**
UNIT 6. Intellectual Property: Introduction to intellectual property: Patents, Copyrights ©, Trademarks ®, Trade Secret, Unfair Competition.	**2 Hrs**

1. **TEXT BOOKS:** Creative Problem Solving for Managers - Tony Proctor - Routledge Taylor & Francis Group
2. 101 Activities for Teaching creativity and Problem Solving - By Arthur B Vangundy - Pfeiffer
3. **REFERENCE BOOKS:** H. S. Fogler and S.E. LeBlanc, Strategies for Creative Problem Solving, Prentice Hall
4. E. Lumsdaine and M. Lumsdaine, Creative Problem Solving, McGraw Hill,
5. J. Goldenberg and D. Mazursky, Creativity in product innovation. Cambridge University Press, 2002.

Course Assignments for internal continuous assessment of 50 Marks (NO written Exam)

- Brain teasers (aka Puzzle Busters, to be solved individually)
- Cartoon captions (small teams)
- Book readings and discussions (small teams)
- Small teams presentations on innovation: (1) innovative individual, (2) innovative company, (3) innovative movie/game, (4) sustainable innovation, (5) innovation in business, (6) innovation in art, (7) innovation in architecture, (8) innovative nation, (9) innovation in science, and (10) innovation in engineering.
- Large groups hands-on projects
- Eight-dimensional (8D) ideation method examples
- Large teams videos

Course Code	Course Title				Category
26HS02PR0105-1	**Liberal/Performing Art Courses** **Course: Fundamentals of Indian Classical Dance: Bharatnatayam**				Regular
Contact Hours per Week			CA	FE	Credits
L	P	S			
0	2	1	25	25	1

Prerequisite: None.

Course Objectives:

The course aims to introduce the students to Bharatnatyam, an important element of Indian traditional knowledge system. The course will not only provide the learning and skill to perform this art but would also enhance many mental and physical aspects of the students such as strength, flexibility, discipline, self-confidence, creativity, focus, coordination, etc.

Course Outcomes

On completion of the course, students will be able to achieve the following:
CO1: Understand the importance of dance and Bharatnataym as an Indian dance form
CO2: Develop skills to perform the dance form at its basic level.
CO3: Evaluate their strengths and interest to take bridge course to give Pratham (1st level formal exam of Bharatnatayam).

Syllabus

Practical -1: Orientation in Bharatnatayam
Practical-2: Tattu Adavu till 8, Naatta Adavu 4 Steps, Pakka Adavu 1 step, Metta Adavu 1

Step, Kuditta Metta Adavu 4 Steps,
Practical -3: Practice sessions
Practical-4: Tatta Kuditta Adavu (Metta), Tatta Kuditta Adavu (Metta) 2 Steps, Tirmanam Adavu 3 Steps, Kattu Adav - 3 Steps, Kattu Adav - 3 Steps
Practical-5: Practice sessions
Practical-6: Tiramanam (front) 3 Steps, Repeat of Tiramanam (Overhead) 3 Steps,
Practical-7: practice sessions
Practical – 8: final practice sessions and performances.

Recommended reading

1. Introduction to Bharata's Natyasastra, Adya Rangacharya, 2011
2. The Natyasastra and the Body in Performance: Essays on the Ancient Text, edited by Sreenath Nair, 2015
3. Bharatanatyam How to ... : A Step-by-step Approach to Learn the Classical Form, Eshwar Jayalakshmi, 2011

Course Code	**Course Title**				**Category**
26HS02PR0105-2	**Liberal/Performing Art Courses** **Course: Fundamentals of Indian Classical Dance: Kathak**				**Regular**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	25	25	**1**

Prerequisite: None.

Course objective

The course aims to introduce the students to Kathak, an important element of Indian traditional knowledge system. The course will not only provide the learning and skill to perform this art but would also enhance many mental and physical aspects of the students such as strength, flexibility, discipline, self-confidence, creativity, focus, coordination, etc.

Course Outcomes

On completion of the course, students will be able to achieve the following:
CO1: Understand the importance of dance and Kathak as an Indian dance form
CO2: Develop skills to perform the dance form at its basic level.
CO3: Evaluate their strengths and interest to take bridge course to give Prarambhik (1st level formal exam of Kathak).

Syllabus

Practical -1: Orientation in Kathak. Correct posture of kathak, Basic Movements and exercise Stepping, Chakkar of 5 count (Bhramari),
Practical -2: practice sessions of practical 1
Practical -3: Hastaks, Hastaks and Steppings, Reciting asamyukta Mudra shloka, Hastak and steppings
Practical -4: practice sessions of practical 3

Practical -5: Todas and Asamyukta hasta mudra shlok, Vandana of Shlok, 2 Todas and Vandana, Ghante Ki Tihai, Practical -6: practice sessions of practical 5 Practical -7: 2 1 Chakkardar Toda and Ginnti Ki Tihai, 2 Todas and 1 Chakkardar Toda, practice sessions Practical -8: Final performances.
Recommended reading 1. Kathak Volume1 A "Theoretical & Practical Guide" (Kathak Dance Book), Marami Medhi & Debasish Talukdar, 2022, Anshika Publication (13 September 2022)

Course Code	**Course Title**				**Category**
26HS02PR0105-3	**Liberal/Performing Art Courses** **Course:** Introduction to Digital Photography				Regular
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	25	25	**1**

Prerequisite: None.

Course objective
The course aims to develop basic skills of students in digital photography to lay a foundation for them as a hobby and/or a profession.

Syllabus
Practical 1: Orientation in digital photography: Genres, camera handling and settings
Practical 2: Rules of Composition
Practical 3: Rules of Composition: practice sessions
Practical 4: Understanding Exposure and Art of Pre-Visualization
Practical 5: Rules of Composition and Art of Pre-Visualization: practice sessions
Practical 6: Post Processing Photographs and Portfolio creation
Practical 7: Post Processing Photographs: practice sessions
Practical 8: Portfolio finalization and presentation in selected genre.

Syllabus
Practical -1: Orientation in Kathak. Correct posture of kathak, Basic Movements and exercise Stepping, Chakkar of 5 count (Bhramari),
Practical -2: practice sessions of practical 1
Practical -3: Hastaks, Hastaks and Steppings, Reciting asamyukta Mudra shloka, Hastak and steppings
Practical -4: practice sessions of practical 3
Practical -5: Todas and Asamyukta hasta mudra shlok, Vandana of Shlok, 2 Todas and Vandana, Ghante Ki Tihai,
Practical -6: practice sessions of practical 5
Practical -7: 2 1 Chakkardar Toda and Ginnti Ki Tihai, 2 Todas and 1 Chakkardar Toda,

practice sessions
Practical -8: Final performances.

Reference material

1. Scott Kelby (2020) The Digital Photography Book: The Step-by-Step Secrets for how to Make Your Photos Look Like the Pros, Rocky Nook, USA
2. Larry Hall (2014) Digital Photography Guide: From Beginner to Intermediate: A Compilation of Important Information in Digital Photography, Speedy Publishing LLC, Newark
3. J Miotke (2010) Better Photo Basics: The Absolute Beginner's Guide to Taking Photos Like a Pro, AMPHOTO Books, Crown Publishing Group, USA

Course Code	Course Title				Category
26HS02PR0105-8	**Liberal/Performing Art Courses Course: Art of Painting**				**Regular**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	25	25	**1**

Prerequisite: None.

Course objective
Painting is fundamentally about learning to see, and to transport that vision onto paper through a variety of mark making techniques. This course aims to develop basic skills of students in painting to lay a foundation for them as a hobby and/or a profession.

Course outcome:
At the end of the course the students will be able to achieve the following:
CO1: Become familiar with the basic methods, techniques & tools of painting.
CO2: Train the eye and hand to develop sense of balance, proportion and rhythm.
CO3: Develop the ability to observe and render simple natural forms.
CO4: Enjoy the challenging and nuanced process of painting.

Syllabus

Practical 1: Orientation in Painting tools & basics of lines, shapes, light, shadows and textures
Practical 2: The art of observation - how to see shapes in drawing
Practical 3: Introduction Water color - how to handle water paints
Practical 4: Introduction to acrylic colors - how to handle acrylic paints
Practical 5: Explore layering paint and capturing the quality of light with paint.
Practical 6: Create landscape painting
Practical 7: Create Abstract painting
Practical 8: Paint on Canvas (try to recreate any famous painting)

Reference material

1. Drawing made easy by Navneet Gala; 2015th edition
2. Alla Prima II Everything I Know about Painting--And More by Richard Schmid with Katie Swatland

3. Daily Painting: Paint Small and Often To Become a More Creative, Productive, and Successful Artist by Carol Marine

Course Code	Course Title				Category
26HS02PR0105-9	**Liberal/Performing Art Courses Course: Art of Drawing**				**Regular**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	25	25	**1**

Prerequisite: None.

Course objective
Drawing is fundamentally about learning to see, and to transport that vision onto paper through a variety of mark making techniques. This course aims to develop basic skills of students in drawing to lay a foundation for them as a hobby and/or a profession.

Course outcome:
At the end of the course the students will be able to achieve the following:
CO1: Become familiar with the basic methods, techniques & tools of drawing.
CO2: Train the eye and hand to develop sense of balance, proportion and rhythm.
CO3: Develop the ability to observe and render simple natural forms.
CO4: Enjoy the challenging and nuanced process of drawing.

Syllabus
Practical 1: Orientation in Drawing tools & basics of lines, shapes, light, shadows and textures
Practical 2: The art of observation how to see shapes in drawing
Practical 3: One/two-point basic linear perspective
Practical 4: Nature drawing and landscapes
Practical 5: Gestalt principles of visual composition
Practical 6: Figure drawing: structure and proportions of human body
Practical 7: Gesture drawing: expression and compositions of human figures
Practical 8: Memory drawing: an exercise to combine the techniques learnt

Reference material

1. Drawing made easy by Navneet Gala; 2015th edition
2. Perspective Made Easy (Dover Art Instruction) by Ernest R. Norling

Course Code	Course Title				Category
26HS02PR0105-10	**Liberal/Performing Art Courses Course: Nature Camp**				Regular
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			

0	2	1	25	25	**1**

Prerequisite: None.

Course Objective: To create an opportunity for the students to develop affinity with nature and thus subsequently impact their ability to contribute towards sustainability of nature.

Course outcome:
After the completion of the course the students will be able to do the following:
CO1: Develop an affinity with nature by observing and understanding it marvels with guidance from experts
CO2: Develop an understanding of the challenges and solutions associated with nature and its conservation.

Course content
In collaboration with the Forest Department and/or a local NGO working in the field of environment conservation, this course would be conducted in 24 hours. Students will be taken to a tiger reserve in Central Indian region or Forest fringe villages or work with an NGO from Central Indian region working on natural resource management. The camps (for 2 days) will cover any one of the following topics as decided by the course coordinator:

1. Awareness about each element of biodiversity (camps on moths, butterflies, birds, other wildlife etc)
2. Environment management (water, forest, wildlife) – practices of Forest Department in managing a tiger reserve, and other aspects of water and forest conservation.
3. Sustainable natural resource management - initiatives by rural communities and local NGOs
4. Man-animal conflict and solutions (socio-economic and technical) – role of local communities and Forest Department
5. Traditional practices in environment conservation – role of local communities and local NGOs

Course Code	**Course Title**				**Category**
26HS02PR0105-11	**Liberal/Performing Art Courses** **Course: Developing Self-awareness**				Regular
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	25	25	**1**

Prerequisite: None.

Course objectives:
The course aims to develop students in their personal as well as professional life by means of graphotherapy, NLP, and Neurobics

Course Outcomes:
On completion of the course, students will be able to achieve the following:
CO1: Gain foundational understanding of graphology and through self-analysis will achieve greater awareness about their strengths and weaknesses & areas for personal growth
CO2: students will be equipped with tools and techniques for continuous self-improvement, using signature analysis and graphotherapy as part of their personal development journey
CO3: understand how to use Neuro Linguistic Programming (NLP) strategies to set and achieve goals effectively, overcoming mental blocks and limiting beliefs.
CO4: Enhance ability to absorb, retain, and recall information, which can benefit academic and professional performance.

Syllabus:

Practical 1: The Power of Handwriting (Handwriting is Brainwriting)
Practical 2: Know yourself through handwriting
Practical 3: The Role of Signature in your life
Practical 4: Graphotherapy to enhance yourself in all ways
Practical 5: Neurolinguistic Programming , S.M.A.R.T Goal
Practical 6: Effective Communication Model, Rapport Building and Anchor
Practical 7: Brain Directives & Linguistic Presuppositions
Practical 8: Neurobics

Course Code	Course Title				Category
26HS02PR0105-12	**Liberal/Performing Art Courses** **Course: Art of Poetry**				Regular
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	25	25	**1**

Prerequisite: None.

Course Outcomes:
To familiarize the students with the art of poetry and develop a sense of appreciation for the art.

At the end of the course the student will be able to achieve the following:
CO1: Understand the origin and development of poetry
CO2: Appreciate the art of poetry in life
CO3: Develop aesthetic sense
CO4: Develop holistic perspective to their personality

Syllabus:
Practical 1: The Power of Handwriting (Handwriting is Brainwriting)
Practical 2: Know yourself through handwriting
Practical 3: The Role of Signature in your life
Practical 4: Graphotherapy to enhance yourself in all ways

Practical 5: Neurolinguistic Programming , S.M.A.R.T Goal
Practical 6: Effective Communication Model, Rapport Building and Anchor
Practical 7: Brain Directives & Linguistic Presuppositions
Practical 8: Neurobics

Reading material

I. The Art of Poetry

1. Fry, S. (2005). The ode less travelled: Unlocking the poetic mind. HarperCollins.
2. Addonizio, K., & Laux, D. (1997). The poet's companion: A guide to the pleasures of writing poetry. W.W. Norton & Company.
3. Lucy, J. (Ed.). (2001). The art of poetry. Penguin Books.

II. Understanding and Interpretation of Poetry

1. Hirsch, E. (1999). How to read a poem: And fall in love with poetry. Harcourt Brace & Company.
2. Pinsky, R. (1998). The sounds of poetry: A brief history. Farrar, Straus and Giroux.
3. Meyer, M. (2005). Poetry: An introduction. Bedford/St. Martin's.

III. Writing Poetry

1. Hugo, R. (1979). The triggering town: Lectures and essays on poetry and writing. W.W. Norton & Company.
2. Bradbury, R. (1990). Zen in the art of writing: Releasing the creative genius within you. Bantam Books.
3. Behn, R., & Twichell, C. (Eds.). (1992). The practice of poetry: Writing exercises from poets who teach. HarperCollins.

Course Code	Course Title				Category
26HS02PR0105-13	Liberal/Performing Art Courses Course: Creative and content writing				Regular
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	25	25	**1**

Prerequisite: None.

Course objective:
The objective of the course is to equip students with comprehensive skills in creative and content writing through experiential learning and real-world applications.

Course outcomes:
On completion of the course, student will be able to achieve the following:
CO1: Understand and apply fundamental concepts and techniques of creative writing.
CO2: Apply storytelling techniques to create engaging narratives.
CO3: Develop and implement effective SEO and digital content strategies
CO4: Create and refine content using various tools and applying diverse writing styles and formats.
CO5: Utilize digital tools to craft multimedia narratives and create a professional portfolio.

Syllabus

Creative Writing
Practical 1: Introduction to Creative and Content Writing
Practical 2: Character and Story Development
Practical 3: Crafting Compelling Narratives

Content Writing
Practical 4: SEO and Digital Content Strategies
Practical 5: Writing for Media
Practical 6: Tools

Content Creation
Practical 7: Digital Storytelling
Practical 8: Creative Portfolio Launch

Course Code	Course Title				Category
26HS02PR0105-14	**Liberal/Performing Art Courses** **Course: Science of life through Bhagwad Gita**				Regular
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	25	25	**1**

Prerequisite: None.

Course Objective
The objective of the course is to seek directions from the Bhagwad Gita to garner life skills for a successful and happy life

Course Outcome
CO1: To understand the methodology to correctly interpret and analysis the scripture
CO2: To understand the application of various teaching of the Bhagwad Gita
CO3: Use meditation and breathing techniques for healthy mind and body.

Syllabus
Practical 1: Introduction to Bhagwad Gita - methodology
Practical 2: Real life application of chapter 1-3
Practical 3: Real life application of chapter 4-6
Practical 4: Real life application of chapter 7-9
Practical 5: Real life application of chapter 10-12
Practical 6: Real life application of chapter 13-15
Practical 7: Real life application of chapter 16-18
Practical 8: Meditation and breathing techniques

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering
Session: 2026-27

Course Code	Course Title				Category
26HS02PR0105-1-1	**Liberal/Performing Art Courses** **Course: Introduction to French Language**				Regular
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	25	25	**1**

Prerequisite: None.

Course Objectives:
To help build a foundation and interest in Spanish language so that the students can pursue the proficiency levels of the language in higher semesters.

Course Outcomes:
On completion of the course, students will be able to achieve the following:

CO1. Demonstrate basic knowledge about Spain, the culture and similarities/differences between India and France
CO2. Learn to use simple language structures in everyday communication.
CO3. Develop ability to write in basic Spanish about themselves and others.
CO4. Develop ability to read and understand beginner level texts in Spanish

Syllabus
Practical-1: Orientation about Spain, the language, and culture
Practical-2: Communication Skills 1: Vocabulary building for everyday conversations
Practical -3: Practice sessions
Practical-4: Reading and writing Skills: Reading and writing simple text in Spanish
Practical-5: Practice sessions
Practical-6: Communication Skills 2: listening comprehension
Practical-7: Practice sessions
Practical-8: Writing Skills: Write basic Spanish and practice
Practical-8: WritingSkills:WritebasicFrenchandpractice

Recommended reading

1. 15-Minute Spanish by Ana Bremon
2. Aula Internacional 1 by Jaime Corpas ,Eva Garcia, Agustin Garmendia.
3. ChicosChicasLibro del Alumno by MaríaÁngeles Palomino

Course Code	Course Title				Category
26HS02PR0105-1-1	**Liberal/Performing Art Courses** **Course: Introduction to French Language**				Regular
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			

0	2	1	25	25	**1**

Prerequisite: None.

Course Objectives:
To help build a foundation and interest in the French language so that the students can pursue the proficiency levels of the language in higher semesters.

Course Outcomes:
On completion of the course, students will be able to achieve the following:

CO1. Demonstrate basic knowledge about France, the culture and similarities/differences between India and France.
CO2. Learn to use simple language structures in everyday communication.
CO3. Develop the ability to write in basic French about themselves and others.
CO4. Develop the ability to understand beginner-level texts in French

Syllabus
Practical-1: Orientation about France, the language, and culture
Practical-2: Communication Skills 1: Vocabulary building for everyday conversations
Practical-3: Practice sessions
Practical-4: Reading and writing Skills: Reading and writing simple text in French
Practical-5: Practice sessions
Practical-6: Communication Skills2: listening comprehension
Practical-7: Practice sessions
Practical-8: Writing Skills: Write basic French and practice

Course Code	**Course Title**				**Category**
26HS02PR0105-1-1	**Liberal/Performing Art Courses** **Course: Introduction to Basic Japanese Language**				Regular
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**T**	**D/P**			
0	0	2	25	25	**1**

Prerequisite: None.

Course Objectives:
The course aims to develop basic communication skills in the Japanese Language and help develop a basic understanding of Japanese cross-cultural communication.

Course Outcomes: On successful completion of the module, students will be able to:

After completing this course, students will be able to

CO1. Gain a brief understanding of Japan as a country and Japanese culture.
CO2. Developability to use vocabulary required for basic level communication in the Japanese language.
CO3. Able to write and read the first script in the Japanese language.
CO4. Able to frame simple sentences in Japanese to handle everyday conversations
CO5. Able to write in basic Japanese about the topics closely related to the learner.

Syllabus

Practical-1: Orientation about Japan, its language, and its culture
Practical-2: Communication Skills 1: Vocabulary for basic Japanese language
Practical-3: Practice sessions
Practical-4: Writing Skills 1: Reading and writing the first script in Japanese
Practical-5: Practice sessions
Practical-6: Communication Skills 2: framing sentences
Practical-7: Practice sessions
Practical-8: Writing Skills 2: Write basic Japanese and practice

Recommended reading

1. Marugoto Starter (A1) Rikai - Course Book for Communicative Language Competences, by the Japan Foundation, Goyal Publishers &Distributors Pvt. Ltd (ISBN: 9788183078047)
2. Japanese Kana Script Practice Book – Vol. 1 Hiragana, by Ameya Patki, Daiichi Japanese Language Solutions (ISBN: 9788194562900)

III SEM SYLLABUS

Course Code	Course Title				Category
25ES04TH0303	**Probability & statistics**				BSC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	0	1	50	50	03

Prerequisite: Basics of Probability and Statistics.

Course Objectives:

The objective of this course is to expose student to understand the basic importance fundamental principles of probability, including probability distributions, random variables, basic statistical methods used for data analysis, inferential statistics, hypothesis testing, confidence intervals, and regression analysis in Robotics and AI.

Course Outcomes:

On successful completion of the module students will be able to:

1.Grasp the meaning of discrete and continuous random variables, probability distribution. Interpret the meaning of probabilities derived from distributions. This involves understanding what the calculated probabilities represent in practical terms and drawing conclusions from the results.
2.Compute probabilities and statistical measures using Binomial, Poisson, and Normal distributions.
3.Calculate joint, marginal, and conditional probabilities using joint probability mass functions

(PMFs) and joint probability density functions (PDFs).
4.Understand the concept of a sampling distribution and its importance in inferential statistics. Also Understand null hypothesis (H0) and alternative hypothesis (H1), significance levels, p-values, and the basic logic behind hypothesis testing.
5.Apply the F-test to determine whether two population variances are significantly different and conduct a Chi-square test to evaluate the association between categorical variables.

UNIT I:	**9 Hrs.**
Probability spaces, conditional probability, Discrete and continuous random variables, expectation and variance of random variable.	

UNIT II:	**9 Hrs.**
Binomial distribution, Poisson distribution, Normal distribution and their applications, exponential distribution.	

UNIT III:	**9 Hrs.**
Joint probability function for discrete and continuous random variables, Marginal probability functions, expectation and variance of multivariate random variables, covariance.	

UNIT IV:	**9 Hrs.**
Small and large sampling, Sampling Distributions, Point and Interval Estimations, Testing of Hypothesis for single mean and proportion for both small and large sample size, testing the means of paired observation.	

UNIT V:	**9 Hrs.**
Testing of Hypothesis for difference of mean and proportion, Test for ratio of variances, Chi-square test for goodness of fit and independence of attributes	

TEXT BOOKS:

1. M R. Spiegal , Theory and Problems of probability and statistics :,2nded :,Schaum series
2. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.

REFERENCE BOOKS:

1. Maurtis Kaptein, Statistics for data science, An introduction to probability, statistics and Data Analysis, Springer 2022.
2. Jay L Devore, Probability and Statistics for Engineering and sciences, 8th edition, Cenage learning.
3. Ray Asfahl. C., “Robots and Manufacturing Automation”, John Wiley & Sons Inc.,1985.
4. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering
Session: 2026-27

Course Code	Course Title				Category
25ES04TH0301	**Thermodynamics**				**Regular**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**D/P**			
03	**0**	**00**	**40**	**60**	**03**
Prerequisite: Engineering Mechanics					
Course Objectives: To present a comprehensive and rigorous treatment of classical thermodynamics while retaining an engineering perspective. To lay the groundwork for subsequent studies in such fields as fluid mechanics, heat transfer and to prepare the students to effectively use thermodynamics in the practice of engineering.					
Course Outcomes: On successful completion of the module students will be able to: CO1: Understand Engineering approach of thermodynamics and identify processes and compute associated heat and work transfer. CO2: Learn balance of energy between the system and its surroundings and apply laws of thermodynamics to thermal utilities. CO3: Understand the concept of Heat engine, Refrigerator & Heat Pumps and understand the II law limitations on energy conversion and concept of entropy. CO4: Analyze the various thermodynamic cycles and thermodynamic relations. CO5: Develop dynamic modeling of manipulator.					
UNIT I: Introduction to Thermodynamics					09 Hrs.
Introduction To Thermodynamics: Basic concepts of Thermodynamics, Zeroth Law of Thermodynamics, Introduction to First Law of Thermodynamics, Heat and Work, The Ideal Gas equation of state, Internal energy and specific heats of gases, Universal Gas Constants.					09 Hrs.
UNIT II: First Law of Thermodynamics First Law of Thermodynamics: Closed Systems, Work done, Change in Internal energy, Heat transferred during various thermodynamic processes, P-V diagrams, Flow work and enthalpy, Steady flow process.					9 Hrs.
UNIT III: Second Law of Thermodynamics Second Law of Thermodynamics: Introduction, Kelvin-Plank & Clausius statements, Heat engines, Refrigerator and Heat pump, Perpetual motion machines, Reversible and Irreversible processes, Carnot cycle, Thermodynamic temperature scale. Entropy: The Clausius inequality, Entropy, Principle of increase of entropy, Change in entropy for Closed and Steady flow open systems.					9 Hrs.
UNIT IV: Properties of System Properties of Steam: Formation of Steam, Application of Steam Table, Dryness fraction, Internal energy of steam, T-S diagram, Mollier chart. Work and Heat transfer during various Thermo dynamics processes with steam as working					9 Hrs.

fluid. Determination of dryness fraction using various calorimeters	
Unit V: Rankine Cycle Simple and Modified Rankine cycle with reheat &regeneration, Binary cycle.	7 Hrs.

TEXT BOOKS:
1. Engineering Thermodynamics: P. K. Nag, Tata Mc-Graw Hill publication
2. Thermodynamics-An Engineering approach: Yunus A. Cengel, Michael A. Boles, Mc-GrawHill publication.
3. Thermal Engineering: R.K. Rajput, Laxmi publications.

REFERENCE BOOKS:
1. Thermal Engineering: P.L. Balaney, Khanna Publisher.
2. Fundamentals of Engineering Thermodynamics: Michael J. Moran, Howard N. Shapiro, Mc- Graw Hill publication
3. Thermal Engineering: V.M. Domkundwar, Dhanpat Rai & Sons.
4. Basic Engineering Thermodynamics: Rayner Joel, Longman Publication.

INTERNET RESOURCES:
1. Basic Thermodynamics by Prof. S K SOM IIT Kharagpur, https://nptel.ac.in/courses/112105123
2. Laws of Thermodynamics by Prof. S K SOM and Suman Chakroborty, IIT Kharagpur https://nptel.ac.in/courses/112105220

MOOC COURSES:

1. Basic Thermodynamics by Prof. S K SOM IIT Kharagpur, https://nptel.ac.in/courses/112105123
Laws of Thermodynamics by Prof. S K SOM and Suman Chakroborty, IIT Kharagpur https://nptel.ac.in/courses/112105220

LIST OF THEORY ASSIGNMENTS: (for theory course)
1. Fundamentals: 25%
2. Design: 25%
3. Application: 25%
4. Research: 25%

LIST OF PRACTICAL ASSIGNMENTS: Any 8 (for lab course)
-

LIST OF MULTIDISCIPLINARY ASSIGNMENTS: -
Class Tests for fundamental understanding

ASSESSMENT SCHEME:
Continuous assessment is done based on overall performance and assignments performance of students through
- Quiz
- MCQ
- Assignments
- Case Studies & Written Assignments

CO/PO Mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2

CO1	3	2	1	1	1	1	1	1	1			1	1	1
CO2	3	1	1	1	1	1							1	
CO3	3	1	1	1	1	1					1	1	1	1
CO4	3	1	1	1			1	1					1	
CO5	3	1	1	1	1	1					1	1	1	1

Relevance to	Employability (%)	Skill Development (%)	Entrepreneurship (%)
% Percentage	70	100	80

Relevance to Or need of	Local Development	National Development	Regional Development	Global Development
(Low /Medium /High)	Middle	High	High	High

FUTURE COURSES: Heat Transfer, Fluid Mechanics, Refrigeration and Air Conditioning

PROFICIENCY IN (SKILLS) : Learning Outcomes
At the time of graduation, all thermodynamics students will have demonstrated:

1. Ability to learn balance of energy between the system and its surroundings and apply laws of thermodynamics to thermal utilities.
2. Ability to understand the concept of Heat engine, Refrigerator & Heat Pumps and understand the II law limitations on energy conversion and concept of entropy.
3. Ability to analyze the various thermodynamic cycles and thermodynamic relations. CO5: Develop dynamic modeling of manipulator.
4. Ability to understand the basics of compressible fluid flow

Course Code	**Course Title**	**Category**
25ES04TH0303	**Manufacturing Engineering**	**Core**

Ramdeobaba University, Nagpur

Department of Mechanical Engineering

Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering

Session: 2026-27

Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**T**	**S**			
02	00	00	50	50	02

Prerequisite: Mechatronics, Engineering Mechanics, Basics of Electrical Engineering.

Course Objectives:

1. To familiarize and get acquainted with major manufacturing process and required Machine Tools.
2. To identify, discuss and select the appropriate process, associated machine and equipment for manufacturing required product.

Course Outcomes: On successful completion of the module students will be able to:

CO1. Understand and classify manufacturing process. Analyze the various casting techniques and patterns for different components.

CO2. Identify the machining parameters, cutting tool materials and cutting fluids for various machining operations.

CO3. Distinguish with constructional details, mechanisms and working principle of various production machines.

CO4. Analyze the suitability of hot and cold working processes.

CO5. Apply the knowledge of suitable joining processes to carry out fabrication work.

UNIT I: INTRODUCTION TO MANUFACTURING PROCESSES **06 Hrs.**

Introduction and classification of manufacturing process, properties of engineering materials and process selection, product life cycle, manufacturing economics.

Molding and Casting - Pattern making types, material, allowances, core types, materials and its properties. Types of molding sand, properties, composition and applications, casting defects. Special Casting Processes - Investment casting, centrifugal casting, shell molding.

UNIT II: METAL CUTTING **05 Hrs.**

Single and multi-point cutting, chip formation, Tool wear and tool life, Surface finish and integrity, Cutting fluids, Cutting tool materials and machinability.

Lathe: specification, construction, work holding devices and tools, attachments for various operations, taper turning, thread cutting operations on Lathe. Unconventional machining processes.

UNIT III: SHAPER AND MILLING MACHINE **05 Hrs.**

Introduction, type, specification, Quick return Mechanisms, Table feed mechanism, work holding devices, shaper operations.

Milling Machine: Introduction, specification, types, mechanisms and attachments for milling, milling operations, Indexing-simple, compound and differential.

UNIT IV: FORMING PROCESSES **05 Hrs.**

Fundamentals of hot and cold working processes, Smithy and forging operations plastic deformation and yield criteria, bulk forming (rolling, extrusion, drawing) and sheet forming (shearing, deep drawing bending).

UNIT V: WELDING **05 Hrs.**

Principles of Welding, classification and types, arc welding, TIG and MIG processes and their parameter selection, welding of cast iron, welding electrode – types, composition, specification. Resistance Welding, Principle, equipment and processes,Gas welding, brazing & soldering.

TEXT BOOKS:

1. Manufacturing Technology, Volume-I&II - P.N. Rao, Tata McGraw Hill Pub. Company, New Delhi.
2. Manufacturing Science - A. Ghosh & A. K. Malik - East West Press Pvt. Ltd. New Delhi.
3. Workshop Technology, Volume-I& II - By Hajra Choudhary, Media Promoters & Publishers Pvt. Ltd.

REFERENCE BOOKS:

1. S. Kalpakjian and S. R. Schimd, Manufacturing processes for engineering materials, 5th Edition - Pearson India, 2014.
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and System.
3. Production Engineering - P. C. Sharma, S. Chand and Company Ltd., New Delhi.

MOOC COURSES:

1. Swayam: Course by Govt of India: Manufacturing Processes - Casting and Joining, IIT Kanpur https://onlinecourses.nptel.ac.in/noc25_me128/preview
2. Swayam: Course by Govt of India: Fundamentals of Manufacturing Processes, IIT Roorkee, https://onlinecourses.nptel.ac.in/noc25_me119/preview

You tube Video on Casting Process

https://www.youtube.com/watch?v=2CIcvB72dmk
https://www.youtube.com/watch?v=DuOMrOqs86s
https://www.youtube.com/watch?v=VveT7Ve7IeQ

LIST OF THEORY ASSIGNMENTS: (for theory course)

1. Fundamentals: 33%
2. Manufacturing Process selection: 33%
3. Applications: 33%

Course Code	**Course Title**				**Category**
25ES04TP0303	**Material Science and Testing SEM III**				PCCr
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**T**	**S**			
02	02	02	50	50	03

Prerequisite: Engineering Mechanics

Course Objectives: This course provides students an understanding of basic structure of materials, ferrous and non-ferrous metals and alloys, heat treatment processes, composites, polymers, ceramics and
smart materials

Course Outcomes: On successful completion of the module students will be able to: **CO1:** Understand crystal structures, defects, and plastic deformation. **CO2:** Interpret cooling curves and phase diagrams. **CO3:** Analyze the iron–iron carbide diagram, solidification and transformation of slowly cooled steel, and heat treatment processes. **CO4:** Investigate the composition, microstructure, properties, and applications of alloy steels, cast iron, and non-ferrous alloys. **CO5:** Evaluate mechanical properties of engineering materials using standard testing methods.	
UNIT I: Classification and properties of engineering materials.	**09 Hrs.**
Structure of materials: crystal structure, space lattice and unit cell, indexing of lattice planes and directions, atomic packing factor. Imperfection in crystals: Point, line, interfacial and volume defects. Plastic deformation: slip,strain hardening, yield point phenomenon	
UNIT II: Alloys, Solid Solutions Alloys, solid solutions, and compounds; Hume–Rothery rules, Gibbs phase rule, and polymorphism; solidification of pure metals including critical nucleus size, crystal shapes, and dendritic growth; cooling curves, non-equilibrium solidification, and coring; equilibrium phase diagrams, lever rule, and microstructure.	**9 Hrs.**
UNIT III: Iron Carbon Phase Diagram Solidification of pure iron, Iron Iron-carbide phase diagram and microstrctural aspects. Critical temperatures. Solidification and transformation of slowly cooled steel and cast-iron. Classification and specification of steel. Heat treatment of Steel, Transformation products of austenite. Isothermal transformation (TTT) diagrams for Fe-C alloys and microstructure development.	**9 Hrs.**
UNIT IV: Alloying of Metals Alloying of steel and effects of alloying elements; classification and applications of alloy steels, stainless steels, and tool steels; cast irons and their types; copper alloys; bearing materials; aluminium, nickel, and titanium alloys; and nanoengineered composites.	**9 Hrs.**
UNIT V: Mechanical Properties Measurements Mechanical Properties measurement: Tensile test -various stress-strain curve, true stress-strain curve, necking, evaluation of properties. Compression test and Torsion test. Hardness test: Brinell and Vickers tests and their relation to strength. Impact tests: Izod, Fatigue test: S-N curve, Creep test. Introduction to nondestructive testing (NDT) & case studies.	**7 Hrs.**
TEXT BOOKS: Text Books: 1. W. D. Callister, 2006, “Materials Science and Engineering - An Introduction”, 6th Edition, Wiley India. 2. Askeland, D. R., & Wright, W. J. (2015). *The science and engineering of materials* (7th ed.). Cengage Learning. 3. V. D. Kodgire & S. V. Kodgire, Material Science and Metallurgy for Engineers, Everest Publishing House. 4. U. C. Jindal, “Engineering Materials and Metallurgy”, Pearson, 2011.	

REFERENCE BOOKS:

1. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.
2. Sindney H Avner , Introduction to Physical Metallurgy, Mc-Graw Hill Education (India) Pvt. Ltd.
3. V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited, 1999.
4. L. Krishna Reddy, Principles of Engineering metallurgy, New Age International Publishers

INTERNET RESOURCES:

1. Introduction to Materials Science and Education https://nptel.ac.in/courses/113102080
2.

MOOC COURSES:

1. Introduction to Materials Science and Education https://nptel.ac.in/courses/113102080,
2. https://www.youtube.com/watch?v=h1TwCUL7Kek&list=PLosblFWvO3kSjK7ute4toqt2s5EsBQX7W

LIST OF PRACTICAL ASSIGNMENTS: Any 8 (for lab course)

1. To study the Metallurgical Microscopes
2. Preparation of specimen for metallo graphic examination.
3. Micro-structural examination of different types of Steels.
4. Micro-structural study of White Cast Iron and Grey Cast Iron.
5. Micro-structural study of Malleable Cast Iron and Nodular Cast Iron.
6. To study the effect of normalizing on properties of steel.
7. To study the effect of annealing on properties of steel.
8. Measurement of hardness with the help of Rockwell Hardness Tester.
9. Measurement of hardness with the help of Brinell Hardness Tester.
10. Determination of tensile properties of ductile material.
11. Determination of impact properties by Izod /Charpy test.
12. Effect of hardening process on properties of steels.

LIST OF MULTIDISCIPLINARY ASSIGNMENTS: -

Mini Project.

ASSESSMENT SCHEME:

Continuous assessment is done based on overall performance and assignments performance of students through

- Quiz
- MCQ
- Mini Project
- Case Studies & Written Assignments
- Laboratory Work

FUTURE COURSES: Strength of Materials , Manufacturing Science

NPTEL Courses: Introduction to Materials Science and Education https://nptel.ac.in/courses/113102080

PROFICIENCY IN (SKILLS) : Learning Outcomes
At the time of graduation, all material science and testing students will have demonstrated:

1. Ability to identify phases and composition of various alloys by metallographic examination using
metallurgical microscope.
2. Ability to get hands on experience on various heat treatment processes.
3. Ability to measure hardness and toughness of engineering materials.
4. Ability to understand working, principle and utilization of UTM to derive various material propertie

Course Code	**Course Title**				**Category**
26ES03TP0304	**Introduction to Python (IIIrd Semester)**				PCC
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	P	**S**			
02	02	00	100	00	03

Prerequisite:

Course Objectives:
1. To provide students with a solid foundation in the Python programming language which makes them to understand and apply fundamental programming concepts
2. To develop students' ability to implement control flow constructs, modular programming through the use of functions

Course Outcomes: On successful completion of the module students will be able to:
CO1. Apply Python fundamentals, control structures, and basic programming constructs to develop logical solutions for computational problems.
CO2. Design and implement modular programs using functions and appropriate built-in data structures for efficient data manipulation.
CO3. Utilize file handling, exception management, and Python libraries to create robust and data-driven applications.
CO4. Integrate Python programming concepts to plan, develop, test, and document mini projects for real-world problem-solving.

UNIT I: Python Fundamentals and Control Structures	**08 Hrs.**
Python installation, IDEs (IDLE, VS Code), Python syntax, keywords, identifiers, variables, data types, type casting, input/output functions, arithmetic operators, logical operators, conditional statements (if, elif, else), loops (for, while), loop control statements (break, continue, pass)	
UNIT II: Functions, Modular Programming, and Data Structures	**9 Hrs.**
Function definition, calling functions, parameters, return values, variable scope (local, global), user-defined functions, string operations and methods, list creation and manipulation, tuple operations, dictionary operations, set operations, Concept of OOPs using Python	
UNIT III: File Handling, Exception Management, and Libraries	**9 Hrs.**

File operations (read, write, append), working with CSV files, structured data handling, exception handling (try, except, finally, raise), math library, random library, datetime library, introduction to numpy, introduction to pandas

UNIT IV: Data Handling, Visualization, and Applications	**8 Hrs.**

Data processing tasks, data cleaning using Pandas, data analysis using NumPy and Pandas, data visualization using Matplotlib (plots, bar charts, histograms, customization), integration of Python concepts for problem-solving, project planning, coding and debugging, testing and documentation, mini project development and presentation.

Textbooks

1. Dr. Charles Severance, *Python for Everybody: Exploring Data in Python 3*, CreateSpace Independent Publishing, 2016.
2. Allen B. Downey, *Think Python: How to Think Like a Computer Scientist*, 2nd Edition, O'Reilly Media, 2016.
3. Mark Lutz, *Learning Python*, 5th Edition, O'Reilly Media, 2013.

Reference Books

1. Eric Matthes, *Python Crash Course: A Hands-On, Project-Based Introduction to Programming*, 2nd Edition, No Starch Press, 2019.
2. Paul Barry, *Head First Programming: A Learner's Guide to Programming Using Python*, O'Reilly Media, 2010.
3. Luciano Ramalho, *Fluent Python: Clear, Concise, and Effective Programming*, 2nd Edition, O'Reilly Media, 2022.
4. Wes McKinney, *Python for Data Analysis*, 3rd Edition, O'Reilly Media, 2022.

List of Experiments

UNIT I: Python Fundamentals and Control Structures

1. Write a Python program to perform basic arithmetic operations (addition, subtraction, multiplication, division) using user input.
2. Develop a program to demonstrate the use of different data types and type casting.
3. Write a program to check whether a number is even or odd using conditional statements.

UNIT II: Functions, Modular Programming, and Data Structures

1. Write a program to define and call a user-defined function to calculate the sum of two numbers.
2. Develop a program demonstrating the use of function arguments and return values.
3. Write a program to demonstrate local and global variables.

UNIT III: File Handling, Exception Management, and Core Libraries

1. Write a program to create, write, and read a text file.
2. Develop a program to handle exceptions using try, except, and finally blocks.
3. Write a program to demonstrate the use of the math, random, and datetime libraries.
4. Develop a program to read and write CSV files.

UNIT IV: Data Handling, Visualization, and Applications

1. Write a program to clean a dataset using Pandas (handling missing values, duplicates).
2. Develop a program to filter and analyze data using Pandas.
3. Write a program to visualize data using Matplotlib (line plot, bar chart).
4. Develop a program to plot a histogram and pie chart using Matplotlib.
5. Write a program integrating NumPy and Pandas for data analysis.

Course Code	**Course Title**				**Category**
25HS04TP0401	**Environmental Science**				VEC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
1	2	1	50	00	1

Prerequisite: comprehensive knowledge about various types of environmental pollution & cultivate an environmentally conscious mind-set among students

Course Objectives:

1. To provide comprehensive knowledge about various types of environmental pollution & cultivate an environmentally conscious mindset among students
2. To familiarize students with modern waste management techniques
3. To impart knowledge about sustainable development practices,
4. To develop the ability to identify, analyze, and critically assess environmental problems and risks

Course Outcomes: On successful completion of the module students will be able to:
CO1: Understand the knowledge regarding different types of environmental pollutions, their causes, detrimental effects on environment and effective control measures.
CO2. Realize the need to change an individual's outlook, so as to perceive our environmental issues correctly, using practical approach based on observations and self-learning.
CO3. Become conversant with recent waste management techniques such as E-wastes, its recycling and management.
CO4. Gain knowledge about the modes for sustainable development, importance of green energy and processes.
CO5. Identify and analyze environmental problems as well as risks associated with these problems and greener efforts to be adopted, to protect the environment from getting polluted.

UNIT I: Air pollution and its control techniques	**4 Hrs.**

Contaminant behaviour in the environment, Air pollution due to SOx, NOx, photochemical smog,
Indoor air pollution,Natural pathways for degradation: Carbon cycle, Sulphur cycle, Nitrogen cycle, Oxygen cycle. Factors responsible for altering the composition of atmosphere (deforestation, burning of fossil fuels, industrial and vehicular emissions, CFCs).Techniques to control Air pollution, ambient air quality and continuous air quality monitoring,
Control measures at source, Kyoto Protocol, Carbon Credits

UNIT II: Noise pollution and its control techniques:	**2 Hrs.**

Introduction to noise pollution and its causes
Noise pollution control: Recent advances in noise pollution control and benefits.

UNIT III: Soil pollution and its control techniques:	**5 Hrs.**

Soil pollution: Soil around us, Soil water characteristics, soil pollution. Solid waste management:
Composting, vermiculture, landfills, hazardous waste treatment, bioremediation technologies, conventional techniques (land farming, constructed wetlands), and phytoremediation. Degradation

of xenobiotics in environment: Petroleum hydrocarbons, pesticides, heavy metals
UNIT IV: Water pollution and its control techniques: **8 Hrs.**
Major sources of water pollution: Eutrophication, acid mine drains, pesticides and fertilizers, dyeing and tanning, marine pollution, microplastics, Techniques to control water pollution: Conventional waste water treatment-types of sewage, sewerage system, alternative systems, primary, secondary and tertiary processes including aerobic and anaerobic techniques, safe disposal.
UNIT V: E-wastes & Environmental Sustainability: Role of Green technology **7 Hrs.**
Introduction, types of e-wastes, environmental impact, e-waste recycling, e-waste management rules Concept of green technologies, categories, goals and significance, sustainability Green energy, green chemistry, challenges to green technology, advantage and disadvantages of green processes, Eco mark certification- its importance and implementation Different government initiatives
TEXT BOOKS: [1] Benny Joseph, Environmental Studies, Mc Graw Hill Education (India) Private Limited [2] B. K. Sharma, Environmental Chemistry, Goel Publishing House, Meerut [3] P Aarne Vesilind, J. Jeffrey Peirce and Ruth F. Weiner, Environmental Pollution and Control, Butterworth -Heinemann
REFERENCE BOOKS: [1] D. D. Mishra, S. S. Dara, A Textbook of Environmental Chemistry and Pollution Control, S. Chand & Company Ltd. Sultan Chand & Company [2] Shree Nath Singh, Microbial Degradation of Xenobiotics, Springer-Verlag Berlin Heidelberg [3] P.T. Anastas & J.C. Warner, Green Chemistry: Theory & practice, Oxford University Press [4] P. Thangavel & Sridevi, Environemental Sustainability: Role of Green technologies, Springer publications.

Course Code	**Course Title**				**Category**
24HS01PR0401	**Environmental Science Lab**				VEC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	50	00	1

Prerequisite: comprehensive knowledge about various types of environmental pollution & cultivate an environmentally conscious mind-set among students
Course Objectives: 1. To provide comprehensive knowledge about various types of environmental pollution & cultivate an environmentally conscious mindset among students 2. To familiarize students with modern waste management techniques 3. To impart knowledge about sustainable development practices, 4. To develop the ability to identify, analyze, and critically assess environmental problems and risks
Course Outcomes: On successful completion of the module students will be able to: **CO1 :** Identify and analyze various types of environmental pollution through practical experiments and field-based data collection. **CO2 :** Develop critical observation skills and an environmentally responsible attitude through self-assessment activities and environmental audits. **CO3 :** Demonstrate understanding of waste management techniques, including segregation, recycling, and handling of E-waste and biodegradable waste. **CO4 :** Apply concepts of sustainable development by experimenting with renewable energy systems and conducting energy efficiency assessments. **CO5 :** Assess environmental risks and propose sustainable, eco-friendly solutions through project-based and research-oriented lab activities. Minimum five practical's to be performed. Practical 1: Analysis of Water Quality Parameters Practical 2: Measurement of Air Particulate Matter Practical 3: Field Visit and Environmental Observation Practical 4: Individual Environmental Audit Practical 5: E-Waste Segregation and Recycling Techniques Practical 6: Organic Waste Composting Practical 7: Energy Audit of a Classroom or Lab Practical 8: Project Presentation on a Greener Initiative

IV SEMESTER SYLLABUS

Course Code	Course Title				Category
26ES04TH00401	**Mechanics of Solids**				**Regular**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	**00**	**00**	**50**	**50**	**3**

Prerequisites
Students should have:

- Basic knowledge of Engineering Mechanics (forces, equilibrium, free body diagrams).
- Understanding of mathematics, including algebra, trigonometry, and elementary calculus.
- Familiarity with properties of materials such as stress and strain.

Course Objectives (COB)

After completing this course, students will be able to:

1. Understand and analyze shear force and bending moment in beams under various loading conditions.
2. Apply principles of bending and shear stress analysis for beam design.
3. Evaluate torsional behavior of shafts and analyze columns for stability and buckling.
4. Determine slope and deflection of beams using analytical methods.
5. Analyze stress distribution in pressure vessels and rotating discs for engineering applications.

Course Outcomes (CO)

After successful completion of the course, students will be able to:

CO1: Construct and interpret shear force and bending moment diagrams for different types of beams and loading conditions.

CO2: Analyze bending and shear stresses in beams and evaluate their effect on structural performance.

CO3: Evaluate torsion in shafts and buckling behavior of columns and struts using appropriate theories.

CO4: Determine slope and deflection of beams using standard analytical methods.

CO5: Analyze and design pressure vessels and rotating discs considering stress distribution and safety.

Unit I: Shear force and Bending Moment Diagram	

Introduction to beams, including definition and classification. Concepts of shear force and bending moment with appropriate sign conventions. Relationship between load, shear force, and bending moment. Concept of point of contraflexure. Construction of shear force and bending moment diagrams for simply supported beams, cantilever beams, and overhanging beams subjected to point loads, uniformly distributed loads (UDL), and uniformly varying loads (UVL).

Unit II: Bending and Shear stresses in Beams	

Bending Stresses: Concept of bending in beams, types of bending such as pure bending and simple bending. Assumptions and theory of simple bending (Euler–Bernoulli theory). Derivation of bending equation. Distribution of bending stress across beam sections. Concept and significance of section modulus.

Shear Stresses: Concept of shear force in beams and development of shear stress due to transverse loading. Assumptions in shear stress analysis. Variation of shear stress across different cross-sections. Shear stress in built-up sections and its practical applications.

Unit III: Torsion of Shafts and Column & Struts	

Torsion of Shafts: Concept of torsion and twisting moment with engineering applications such as shafts, axles, rotors, and robotic joints. Theory of pure torsion, including assumptions and derivation. Distribution of shear stress along the radius. Polar moment of inertia and its significance. Power transmission by shafts and relationship between power, torque, and angular velocity. Analysis of combined and composite shafts.

Column & Struts: Definition and classification of columns and struts. Types of end conditions and their effect on buckling strength. Concept of effective length, radius of gyration, and slenderness ratio. Euler's theory of columns, including assumptions and derivation of buckling load. Rankine's formula and comparison with Euler's theory.

Unit IV: Deflection and slop of Beams	

Concept of slope and deflection in beams. Elastic curve and its significance. Relationship between load, shear force, bending moment, slope, and deflection. Derivation of the governing differential equation of the elastic curve. Methods for determining slope and deflection, including double integration method, Macaulay's method, moment-area method, and an introduction to conjugate beam method and Castigliano's theorem.

Unit V: Pressure Vessels and Rotating Discs

Pressure Vessels: Definition and applications of pressure vessels. Classification into thin-walled and thick-walled vessels. Assumptions of thin cylinder theory. Stresses in thin cylindrical vessels, including circumferential (hoop) and longitudinal stresses. Stress analysis of thin spherical shells. Limitations of thin cylinder theory. Introduction to thick cylinders and variation of stresses across thickness.

Rotating Discs: Introduction and applications of rotating disc i.e. flywheels. Stresses in rotating discs, including radial and circumferential stresses. Analysis of rotating discs with uniform thickness (solid discs) and stress distribution along the radius. Stress analysis of rotating discs with central holes and the effect of inner and outer radii.

Text Books:

1. Rattan, S.S., Strength of Materials, McGraw Hill Education, Latest Edition.
2. Beer, F.P. & Johnston, E.R., Mechanics of Materials, McGraw-Hill.
3. Bansal, R.K., Strength of Materials, Laxmi Publication

Reference Books:

1. Gere, J.M. & Timoshenko, S.P., Mechanics of Materials, CBS Publishers.
2. Hibbeler, R.C., Mechanics of Materials, Pearson Education.
3. Popov, E.P., Engineering Mechanics of Solids, Prentice Hall.

Relevance of Course:

1. The units on mechanisms and machines form the foundation of robot design. Concepts like kinematic chains, degrees of freedom, and inversions are exactly what define how a robot arm, gripper, or mobile platform moves. Without this, it's difficult to understand how joints, links, and actuators translate control signals into real motion.
2. The study of applications of mechanisms (four-bar chains, slider-crank, Geneva mechanisms, etc.) is highly relevant in robotics hardware. Many robotic systems—like pick-and-place arms, walking robots, or indexing mechanisms—are based on these classical designs. Drives such as belt, chain, and gears are essential for power transmission in robotic systems.
3. Cams and followers are important for motion planning at a mechanical level. Even though modern robots use motors and controllers, cam profiles help in understanding smooth motion generation, velocity control, and avoiding jerks—concepts that are later implemented through algorithms in robotics.
4. The units on stress and strain are crucial for designing safe and efficient robotic structures. Robotic arms, frames, and joints must withstand loads without failure or excessive deformation. Knowledge of material behavior helps in selecting lightweight materials, which is critical for energy-efficient robots and drones.
5. Compound stresses and strain energy are essential for analyzing real-world loading conditions where multiple forces act simultaneously. This is important in robotic joints, end-effectors, and moving parts. Strain energy concepts also relate to shock absorption and impact handling, which are key in autonomous systems operating in dynamic environments.

Course Code	**Course Title**		**Category**
26ES03TP0401	**Kinematics and Dynamics of Robot**		Professional Core
Contact Hours per Week	**CA**	**ESE**	**Credits**

L	P	Total			
03	02	05	50+50	50	**04**

Prerequisites:
Students should have:

1. Basic knowledge of Mathematics, including linear algebra (matrices), trigonometry, and calculus.
2. Understanding of Engineering Mechanics, especially rigid body motion and coordinate systems.
3. Familiarity with vector operations and coordinate geometry in 2D and 3D space.
4. Basic understanding of mechanisms and machine kinematics.
5. Fundamental knowledge of programming or computational tools (MATLAB/Python) for numerical analysis.

Course Objectives:
After completing this course, students will be able to:

1. Understand and apply coordinate transformations and frame mapping for representing robotic systems.
2. Develop forward kinematic models of robotic manipulators using D-H parameters.
3. Formulate and solve inverse kinematics problems for different robotic configurations.
4. Analyze velocity relationships, Jacobian matrix, and singularities in robotic manipulators.
5. Model and analyze robot dynamics and trajectory planning for controlled motion.

Course Outcomes (CO)
After successful completion of the course, students will be able to:
CO1: Apply coordinate frame transformations and homogeneous matrices to represent position and orientation of robotic systems.
CO2: Develop and analyze forward kinematics models of manipulators using Denavit–Hartenberg (D-H) convention.
CO3: Solve inverse kinematics problems and evaluate multiple solutions, singularities, and workspace constraints.
CO4: Analyze Jacobian matrices, velocity relationships, and manipulability of robotic systems.
CO5: Formulate dynamic models and trajectory plans for robotic manipulators using Lagrangian and Newton–Euler methods.

UNIT I: Coordinate Frames, Mapping & Transforms	**08 Hrs.**

Significance of Coordinate Frames, Mapping & Transforms in robotics. Description of object in space, Mapping between rotated frames, translated frame and combined rotation & translation. Homogeneous transformation, Difference between fixed & movable frame, Composite/multiple transformation, Fixed angle rotation and Euler angle rotation.

UNIT II: Forward Kinematics of Robot	**08 Hrs.**

Introduction manipulator kinematics, Mechanical structure and notation, Description of links and joints, kinematic modelling of the manipulator, Difference between direct and inverse kinematics, Denavit-Hartenberg (D-H) notation and algorithms, Kinematic relationship between adjacent link, Manipulator Transformation Matrix, Workspace analysis.

UNIT III: Inverse Kinematics of Robot	**08 Hrs.**

Problem formulation of inverse kinematics, Analytical and numerical methods, Closed-form solutions for simple manipulators (2R and 3R planer), Redundant manipulators, Multiple solutions and singular configurations, Workspace and reachability analysis

UNIT IV: Jacobian and Singularity Analysis	**8 Hrs.**

Linear and angular velocity of a rigid body, relationship between transformation matrix and angular velocity, Jacobian matrix and its significance, Jacobian inverse, Jacobian Singularity, Manipulability, Dexterity analysis of manipulators, Redundancy and its impact on kinematic performance.

UNIT V: Dynamic modelling & Trajectory planning	**8 Hrs.**

Lagrangian mechanics, Dynamic model of n-DOF manipulator, Lagrange-Euler and Newton-Euler formulation to dynamic solution. Inverse Dynamics, Terminology related to trajectory planning, trajectory planning to determine the joint velocity and acceleration.

TEXT BOOKS:

- Robert J. Schilling, Fundamentals of Robotics Analysis and Control, PHI Learning, 2009.
- Craig J. J., Introduction to Robotics: Mechanics and Control, 3rd Edition, Addison-Wesley, Reading, MA, 2005.
- Odrey, Mikell P. Groover& Nicholas G., Mitchel Weiss, Roger N. Nagel, and Ashish Dutta. "Industrial Robotics,
- Technology programming and Applications.", McGraw Hill Education; 2nd edition (July 2017).

REFERENCE BOOKS:

- P. A. Janaki Raman, Robotics and Image Processing An Introduction, Tata MCGraw Hill Publishing company Ltd., 1995.
- Shames I. H., Engineering Mechanics- Statics and Dynamics" $/e Prentice-Hall of India Pvt. Ltd., 2005.

Course: Kinematics and Dynamics of Robot Lab

Course Objectives:

The objectives of this course are to:

1. Provide practical exposure to the structure, working and programming of a six-axis industrial arc welding robot.
2. Enable students to apply concepts of coordinate transformations, kinematics, dynamics, and trajectory planning using simulation and analytical tools.
3. Develop skills in robotic welding path planning and execution for straight-line and circular welding applications.

Course Outcomes:

After successful completion of this course, the students will be able to:

1. Apply concepts of coordinate transformations, kinematics, dynamics, and trajectory planning to analyze and simulate the motion of n-DOF robotic manipulators.
2. Develop and execute robot programs for a six-axis industrial arc welding robot, ensuring safe operation and accurate motion control.
3. Plan and perform robotic arc welding paths such as straight-line and circular welding, and evaluate the effectiveness of path planning and execution.

List of Experiments:

1. Familiarization with the structure and working of six axis YASKAWA arc welding robot.

2. Study and Implementation of Homogeneous Transformations in Robotics using RoboAnalyser

Numerical based on coordinate frames and transformations using RoboAnalyser.

3. Forward kinematics (FK) of n-DOF robots using RoboAnalyser and validate the FK solution with MATLAB.
4. Inverse kinematics (FK) of n-DOF robots using RoboAnalyser and validate the FK solution with MATLAB.
5. Trajectory Planning of n-DOF robots using RoboAnalyser.
6. Forward dynamics of n-DOF robots using RoboAnalyser.
7. Inverse dynamics of n-DOF robots using RoboAnalyser.
8. Robot programming of six axis YASKAWA arc welding robot.
9. Straight-Line Butt-Welding Path Planning using six axis YASKAWA arc welding robot.
10. Circular Welding on Pipe or Plate Path Planning using six axis YASKAWA arc welding robot.

Experiment 1
Imitation and Familiarization with Six-Axis YASKAWA Arc Welding Robot
Experiment 2
Manipulation of Homogeneous Transformations using RoboAnalyser
Experiment 3
Precision in Coordinate Frame Modeling and Transformation Analysis using RoboAnalyser
Experiment 4
Articulation of Forward Kinematics of n-DOF Robots using RoboAnalyser and MATLAB
Experiment 5
Articulation of Inverse Kinematics of n-DOF Robots using RoboAnalyser and MATLAB
Experiment 6
Precision and Articulation in Trajectory Planning of n-DOF Robots using RoboAnalyser
Experiment 7
Articulation of Forward Dynamics Analysis of n-DOF Robots using RoboAnalyser
Experiment 8
Articulation of Inverse Dynamics of n-DOF Robots using RoboAnalyser
Experiment 9
Manipulation to Precision in Programming of Six-Axis YASKAWA Arc Welding Robot
Experiment 10
Precision and Articulation in Straight-Line Butt Welding Path Planning using YASKAWA Robot

Relevance of Course

- The study of coordinate frames and transformations is fundamental in robotics, as every robot must understand its position and orientation in space. These concepts are used in computer vision, localization, and mapping (SLAM), where robots interpret sensor data and navigate environments accurately.
- Forward and inverse kinematics are the backbone of robot motion. Forward kinematics helps determine the position of the end-effector from joint parameters, while inverse kinematics allows the robot to compute joint movements required to reach a desired target. These are essential in applications like robotic arms, pick-and-place systems, and autonomous manipulation tasks.

- The Jacobian matrix and singularity analysis are crucial for understanding velocity, force transmission, and control of robots. They are widely used in real-time control systems, enabling smooth and precise movements, and in avoiding configurations where the robot loses control or flexibility.
- Dynamic modeling connects motion with forces and torques, which is necessary for designing efficient and stable robotic systems. It plays a key role in robot control algorithms, especially in high-speed or precision tasks.
- Trajectory planning is where robotics meets AI directly. It involves planning smooth, efficient, and collision-free paths for robots. AI techniques enhance this by optimizing paths, adapting to dynamic environments, and enabling autonomous decision-making.

Course Code	**Course Title**				**Category**
25ES04TP0403	**Fluid Mechanics and Hydraulic machines**				PCC
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
3	2	2	50	50	4

Prerequisite: Students should have a fundamental understanding of Mathematics, including algebra, trigonometry, and basic calculus (differentiation and integration). They should be familiar with core Physics concepts such as force, pressure, work, energy, and properties of matter. A basic knowledge of fluid properties (density, viscosity, and surface tension) and principles of statics and dynamics is essential.

Course Objectives:
On the completion of this course students will,
1.Build a foundation in fluid mechanics principles and enable students to analyze fluid behaviour in engineering systems involving flow measurement, pipe flow, and jet forces.
2.Develop the ability to understand, evaluate, and apply the working principles and performance characteristics of hydraulic turbines and pumps used in hydraulic power systems**.**

Course Outcomes: On successful completion of the module students will be able to:
CO1: Explain the fundamental properties of fluids, classify types of flows, and evaluate viscous and turbulent flow behaviour including losses in pipe flow systems.
CO2: Apply continuity, momentum, Euler's, and Bernoulli's equations to analyze fluid kinematics and dynamics, and use these principles in flow measurement devices like venturimeter, orifice meter, and pitot tube.
CO3: Analyze the impact of fluid jets on various surfaces using momentum principles and interpret the functioning of hydropower systems.
CO4: Understand the working principles, velocity triangles, efficiencies, and performance characteristics of Pelton, Francis, and Kaplan turbines.
CO5: Evaluate the working, velocity components, performance curves, NPSH, priming, and cavitation characteristics of centrifugal and reciprocating pump

UNIT I: Fundamentals of Fluid Mechanics, Flow types and Flow Through Pipes	**8 Hrs.**

Definition of fluid, Newton's law of viscosity,properties of fluids:mass density, specific volume, specific gravity, viscosity, compressibility, and surface tension; Types of flow, Reynolds number and significance; flow of viscous fluids through; boundary layer concepts types of boundary layers; Flow through pipes, energy losses in pipes; pipes in series and parallel.	
UNIT II: Fluid Kinematics and Dynamics	**8 Hrs.**
Application of continuity equation and momentum equation; incompressible flow Continuity equation in one & three dimensions; differential velocity field; stream function and streamlines; types of flow; basics of kinematics of flow; Euler's equation of motion; Bernoulli's equation, assumptions and limitations; applications of Bernoulli's theorem:Venturimeter, orifice meter, and pitot tube.	
UNIT III: Impact of Jet and Hydropower Systems	**8 Hrs.**
Impact of jet and jet propulsion: Momemtum principle, Dynamic action of jet on fixed and moving plates, curved vanes, series of plates and vanes, velocity triangles and their analysis, Introduction to hydroelectric power plant.	
UNIT IV: Hydraulic Turbines	**7 Hrs.**
Classification of water turbines, heads and efficiencies, velocity triangles- Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles –draft tube- Specific speed, unit quantities, performance curves for turbines ,governing of turbines.	
UNIT V: Hydraulic Pumps	**7 Hrs.**
Theory of Rotodynamic machines – Various efficiencies, velocity components at entry and exit of the rotor, velocity triangles – Centrifugal pumps, working principle, work done by the impeller, performance curves , concept of NPSH – (net positive suction head),priming,cavitation in pumps, Reciprocating pump – working principle	
UNIT VI: Hydraulic Machines	**7 Hrs.**
Theory of Rotodynamic machines :Various efficiencies , velocity components at entry and exit of the rotor, velocity triangles :Centrifugal pumps, working principle, work done by the impeller, performance curves , concept of Net positive suction head, priming,cavitation in pumps, Reciprocating pump – working principle.	
TEXT BOOKS: 1. Fluid Mechanics & Machines: R. K. Bansal- Laxmi publications. 2. A text book of Fluid Mechanics : R.K. Rajput, S.Chand Publication.	
REFERENCE BOOKS: 1.Theory of Turbo-Machines: A. T. Sayer- McGraw Hill. 2. Fluid Mechanics: Som & Biswas - Tata McGraw-Hill. 3.Fluid Mechanics & Fluid Power Engineering: D. S. Kumar -S. K. Kataria Publications	
Relevance of the Course for Higher Semester Subjects: Fluid Mechanics and Hydraulic Machines form a foundational base for several advanced engineering subjects. The concepts of fluid behavior, pressure distribution, and flow dynamics are essential for understanding subjects like advanced fluid dynamics, turbomachinery, and hydraulic engineering. Knowledge gained in this course supports in courses, where fluid flow and energy interactions play a critical role. Additionally, principles of fluid mechanics are widely applied in the analysis and design of systems involving pipelines, pumps, turbines, and fluid transport mechanisms. This course also prepares students for computational subjects such as Computational Fluid Dynamics (CFD), where mathematical modelling of fluid flow is required. Overall, for solving real-world engineering problems in higher semesters.	

Course Code	**Course Title**		**Category**
25ES04TP0403	**Fluid Mechanics and Hydraulic machines Lab**		PCC
Contact Hours per Week	**CA**	**ESE**	**Credits**

L	P	S			
0	2	0	50	00	1

Prerequisite: Students should have a fundamental understanding of Mathematics, including algebra, trigonometry, and basic calculus (differentiation and integration). They should be familiar with core Physics concepts such as force, pressure, work, energy, and properties of matter. A basic knowledge of fluid properties (density, viscosity, and surface tension) and principles of statics and dynamics is essential

Course Objectives:
1.The objective of this course is to give practical insite on constructional details of various hydraulic machines also to enable the students to evaluate performance of these machines.
2.The objective is also to understand various losses in pipes and to determine Cd, Cc and Cv.

Course Outcomes: On successful completion of the module students will be able to:
CO1: Perform and demonstrate fluid flow experiments using devices such as Venturimeter, Orificemeter, and mouthpieces by following standard laboratory procedures and safety practices.
CO2.Measure and determine hydraulic parameters such as coefficient of discharge, hydraulic coefficients, and friction factor for different flow systems with accuracy.
CO3. Analyze experimental data to evaluate major and minor losses in pipes and interpret performance characteristics of turbines and pumps.
CO4. Evaluate the performance of hydraulic machines (Pelton turbine, Francis turbine, centrifugal and reciprocating pumps) and compare results with theoretical values to draw engineering conclusions.

The laboratory will have minimum Eight Practical :

1. Determination of coefficient of discharge for Venturi meter
2. Determination of coefficient of discharge for Orifice meter
3. Determination of hydraulic coefficients C and C for orifice dc
4. Determination of hydraulic coefficients C and C for mouthpiece dc
5. Determination of Darcy Friction factors for different pipes
6. To calculate efficiency of Pelton turbine
7. To calculate efficiency of Francis turbine
8. To calculate efficiency of Centrifugal pump
9. To Study the working of Reciprocating pump
10. To determine minor losses in pipe flow
11. Bernaouli's Experiment

Course Code	Course Title				Category
25ES04TP0404	**Manufacturing Technology**				PCC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	2	2	50	50	3

Prerequisite: Manufacturing Processes.

Course Objectives:
The objective of the course is to prepare the students:

1. To learn the tooling needed for manufacturing, tolerance systems and design assembly gauges
2. To measure the dimensional accuracy and apply the Quality Control techniques in manufacturing process

Course outcomes

At the end of this course students will be able to:

1. To provide knowledge on machines and related tools for manufacturing and process planning.
2. Develop conceptual understanding of tolerance systems and design assembly gauges.
3. Develop and apply knowledge of engineering metrology and measuring equipment's.
4. Analyze and interpret technical data through Quality Control techniques.
5. Analyze and interpret technical data through acceptances sampling and inspection

UNIT I: Die and Mold Design	**6 Hrs.**

Tooling for conventional and non-conventional machining processes, mould and die design, press tools – configuration, working of die and punch; principles of forging die design. jigs and fixtures, principles, design and applications. Interpretation and significance of process planning, steps in process planning, classification of operations, sequencing of operations

UNIT II: Limits, fits and tolerances	**9 Hrs.**

Limits, fits and tolerances, tolerances limits, types of fits, types of allowances, shaft basis system and hole basis system, tolerance analysis in assembly, taylor's principle, design of limit gauges. selective assembly, interchangeability.

UNIT III: Metrology	**9 Hrs.**

Metrology: definition, standard of measurements, methods of measurement, instruments for linear and angular measurements, measurement of straightness and flatness, measurements of thread, characteristics of surface finish, precautions while using an instruments for getting higher precision and accuracy.

UNIT IV: Quality and quality control	**6 Hrs.**

Quality and quality control: definition, function, objective and characteristics. quality of design and conformance, statistical quality control (SQC), process capability and control limits, causes of variation, control charts for variables and attributes.

UNIT V: Acceptance sampling for inspections	**6 Hrs.**

Acceptance sampling for inspections, comparison with 100% inspection, different types of sampling plans, OC curve- importance and significance, producers risk, consumer's risk, production planning and control, types and characteristics of production systems, Total quality management.

Text Books:

1. Manufacturing processes for engineering materials: Kalpakjian and Schmid, Pearson India
2. Engineering Metrology: R.K. Jain- Khanna Publications, Delhi
3. Statistical Quality Control: M. Mahajan- Dhanpat Rai Publications, Delhi

Reference Books:

1. Production Engineering: P.C. Sharma- S. Chand Publications, Delhi
2. Statistical Quality control: E. L. Grant, Mc Grow-Hill, Delhi (Noida)
3. Production Technology: O. P. Khanna, Dhanpat Rai Publications, Delhi

Course Code	**Course Title**				**Category**
25ES04TP0404	**Manufacturing Technology Lab**				PCC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	50	00	1

Prerequisite: Manufacturing processes

Course Objectives

The objective of the course is to prepare the students:

1. To handle the various precise engineering tools and equipments and
2. To interpret technical data Quality Control Techniques

Course outcomes

At the end of this course students will be able to:

1. Ability to understand the knowledge of engineering metrology, its working principles and various measurement practices.
2. Learn to handle the various modern engineering tools and equipments for linear and angular measurements
3. Ability to interpret technical data of the various precise instruments Tool Maker's Microscope, Profile projector, etc.
4. To design and learn from case studies on assembly fits & limits gauges
5. To learn from case study approach on Quality Control Techniques

List of experiments based on following topics:

1. Measurement of linear dimensions with Vernier Caliper.
2. Measurement of linear dimensions with Vernier height gauge & depth gauge.
3. Measurement of linear dimensions with Micrometer screw gauge.
4. Measurement of angular dimensions with bevel protector.
5. Measurement of angular dimensions with sine bar and slip gauges.
6. Measurement of straightness with Autocollimator.
7. Study and use of Optical flat.
8. Measurement of screw dimensions using Tool Maker's Microscope.
9. Measurement of screw dimensions using Profile projector.
10. Case study: To study in detail the power presses.
11. Case study. To learn from case studies on design of assembly fits & limits gauges
12. Case study. To learn from case study approach on Quality Control Techniques

Text Books:

1. Manufacturing processes for engineering materials: Kalpakjian and Schmid, Pearson India
2. Engineering Metrology: R.K. Jain- Khanna Publications, Delhi
3. Statistical Quality Control: M. Mahajan- Dhanpat Rai Publications, Delhi

Reference Books:

1. Production Engineering: P.C. Sharma- S. Chand Publications, Delhi
2. Statistical Quality control: E. L. Grant, Mc Grow-Hill, Delhi (Noida)
3. Production Technology: O. P. Khanna, Dhanpat Rai Publications, Delhi

Course Code	Course Title				Category
25ES04PR0405	**PROJECT - I**				CEP/FP
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
00	02		50	-	01
Prerequisite: Introduction to Python,					

Course Objectives:

1. To enable students to identify, analyze, and define a real-world engineering problem and develop an appropriate problem statement through literature review and preliminary investigation.
2. To develop skills in project planning, research methodology, and initial design or model development using appropriate tools and techniques.

Course Outcomes: On successful completion of the module students will be able to:
CO1 Identify and define a real-world problem related to mechanical engineering by reviewing relevant literature and understanding system requirements.
CO2 Analyze and design an appropriate methodology or system architecture using fundamental concepts of mechanical engineering.
CO3 Implement a basic hardware/software solution using suitable tools, programming languages, or simulation platforms to address the identified problem.
CO4 Evaluate and interpret results obtained from the developed system and analyze performance with respect to objectives and constraints.
CO5 Demonstrate effective teamwork and technical communication through seminars, presentations, documentation, and viva-voce.

SYLLABUS	**25 Hrs.**

Introduction to project-based learning, identification of problem domains, literature survey and review of research papers, formulation of problem statement and objectives, feasibility analysis, selection of methodology and tools, basic design or model development, data collection and preliminary analysis, use of computational or experimental techniques, project planning and scheduling, documentation practices, report writing, and presentation of progress work.

Course Code	**Course Title**				**Category**
25ESAEC04PR0605	**Advanced Competitive coding**				AEC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
00	02	00	50	00	01

Prerequisite: Basics of Python and Data Structure and Basic Competitive Coding

Course will be delivered by Industry Vendor.

Course Objectives:

- To strengthen problem-solving skills using advanced data structures and algorithms.
- To prepare students for coding interviews and competitive programming contests.

Course Outcome :

1. Apply advanced data structures like stacks, queues, and hash tables.
2. Solve medium to hard problems using optimized approaches.
3. Use recursion and backtracking for complex problems.
4. Apply problem-solving strategies for competitive coding contests.
5. Perform efficiently in coding platforms and timed challenges.

Module 1: Advanced Arrays, Strings & Sliding Window **04x2 Hrs**

1. Prefix sum
2. Sliding window technique
3. Two-pointer approach

Module 2: Stacks, Queues & Hashing **04x2 Hrs**

1. Stack applications (infix-postfix, next greater element)
2. Queue (circular, deque)
3. Hash tables & collision handling

Module 3: Recursion, Backtracking & Problem Solving **04x2 Hrs**

- N-Queens, subsets, permutations
- Maze problems
- Optimization techniques

List of Experiments

- Solve 10 problems using sliding window & two-pointer techniques
- Implement stack applications (infix to postfix, evaluation)
- Solve queue-based problems (circular queue, deque)
- Implement hashing and solve collision problems
- Backtracking problems (N-Queens, subsets, permutations)
- Solve at least 15 problems on LeetCode (Medium level)
- Participate in 1 mock coding contest

Recommended Books

1. "Data Structures Using C" – Reema Thareja
2. "Introduction to Algorithms" – Cormen (Basic reference)
3. "Programming in C/C++/Java" – Standard texts

Web Resources

- HackerRank
- HackerEarth
- LeetCode
- CodeChef, GeeksforGeeks

Evaluation Scheme

Component	Marks	Description
AMCAT Score	10	Automata and Automata Fix
Test-1 By Vendor	20	Assessment will be done by Vendor. Quiz , Coding Test
Test 2 By Vendor	20	Assessment will be done by Vendor. Quiz , Coding Test

Course Code	**Course Title**		**Category**		
25ES04AECPR0408	**Basic Competitive coding**				AEC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
00	02	00	50	00	01
Prerequisite: Basics of Python and Data Structure					

Course will be delivered by Industry Vendor.

Course Objectives:

- To develop fundamental problem-solving skills using basic data structures and algorithms.
- To enable students to solve coding problems using online competitive platforms.

Course Outcome :

1. Understand problem statements and implement basic algorithms.
2. Apply arrays and string manipulation techniques.
3. Solve problems using recursion and basic backtracking.
4. Implement searching and sorting techniques.
5. Use online assessment effectively for coding practice.

Module 1: Fundamentals & Problem Solving **04x2 Hrs**

1. Algorithm basics, pseudocode, flowcharts
2. Time & space complexity (intro level)
3. Input/output handling in coding platforms

Module 2: Arrays, Strings & Recursion **04x2 Hrs**

1. 1D/2D arrays
2. String operations
3. Recursion basics (factorial, Fibonacci, simple problems)

Module 3: Searching, Sorting & Basic Data Structures **04x2 Hrs**

- Linear & binary search
- Basic sorting (bubble, selection, insertion)
- Introduction to stacks & queues

List of Experiments

1. Solve 5 problems on basic input/output and logic building
2. Implement array operations (search, sum, reverse)
3. String manipulation problems (palindrome, substring, frequency count)
4. Recursive problems (factorial, Fibonacci, sum of digits)
5. Searching & sorting implementation and problem-solving
6. Solve at least 10 problems on HackerRank (Easy level)
7. Mini contest (timed coding test)

Recommended Books

1. "Data Structures Using C" – Reema Thareja
2. "Introduction to Algorithms" – Cormen (Basic reference)
3. "Programming in C/C++/Java" – Standard texts

Web Resources

- HackerRank
- HackerEarth
- LeetCode
- CodeChef, GeeksforGeeks

Component	Marks	Description
AMCAT Score	10	Automata and Automata Fix
Test-1 By Vendor	20	Assessment will be done by Vendor. Quiz , Coding Test
Test 2 By Vendor	20	Assessment will be done by Vendor. Quiz , Coding Test

V SEMESTER SYLLABUS

Course Code	Course Title				Category
26ES04TH00401	**Mechanical Systems Design**				**Regular**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	**00**	**00**	**50**	**50**	**3**

Prerequisites
Students should have:

1. Basic knowledge of Engineering Mechanics (forces, equilibrium, stress analysis).
2. Understanding of Mechanics of Solids / Strength of Materials (stress, strain, torsion, bending).
3. Familiarity with material properties and behavior under loading.
4. Basic knowledge of manufacturing processes and machine elements.

Course Objectives (COB)

- Understand the fundamentals of machine design, material selection, design standards, and behavior of machine elements under static loading conditions.
- Understand the behavior of materials under fluctuating and cyclic loading and the principles of fatigue failure in machine components.
- Understand the design principles, failure mechanisms, and strength analysis of riveted, bolted, and welded joints under different loading conditions.
- Understand the function, types, and mechanical behavior of springs under static and fatigue loading conditions.
- Understand the design principles of shafts and keys under combined loading and their role in power transmission systems.

Course Outcomes (CO)

CO1: Apply fundamental design principles, material selection, and failure theories to analyze and design machine elements subjected to static loads.
CO2: Analyze fatigue behavior of machine elements and design components using fatigue failure criteria such as Soderberg, Goodman, and Gerber theories.
CO3: Design and evaluate riveted, bolted, and welded joints for static and eccentric loading conditions in engineering applications.
CO4: Design springs for engineering applications by analyzing stress, deflection, and fatigue performance of different types of springs.
CO5: Design shafts and keys considering combined bending, torsion, rigidity, and stress concentration for safe power transmission.

Unit I: Fundamentals of Machine Design and Design Against Static Loads

Introduction to machine design, phases of design and general design procedure. Considerations in design including **functional requirements, strength, stiffness, reliability, manufacturability, ergonomics, and aesthetics**. Selection of materials based on mechanical properties, cost, and application. Standardization, preferred numbers, and use of **design codes and standards (ISO, BIS, ASME)**.
Theories of elastic failure: maximum principal stress theory, maximum shear stress theory, distortion energy theory, and their applications in design.
Design of machine elements under static loading such as **cotter joints, knuckle joints, and pinned connections**, including failure modes and design calculations.

Unit II: Design Against Fatigue Loads

Types of dynamic loading: fluctuating, alternating, and shock/impact loads. Mechanism of **fatigue failure** and concept of endurance limit. S–N curve and fatigue life estimation.
Factors affecting fatigue strength: surface finish, size effect, temperature, stress concentration, reliability, and loading conditions. **Notch sensitivity and fatigue stress concentration factor**.
Design for fatigue loading using failure criteria: Soderberg criterion, Goodman criterion, Gerber criterion
Introduction to **cumulative damage (Miner's rule)** and design for variable loading conditions

Unit III: Design of Riveted, Bolted and Welded Joints

Riveted and Bolted Joints:
Types of joints (lap and butt joints), modes of failure (tearing, shearing, crushing). Efficiency of joints and its significance. Design of riveted and bolted joints for **boilers, pressure vessels, and structural applications**. Eccentrically loaded joints and analysis of load distribution.
Welded Joints:
Types of welded joints (butt and fillet welds), welding symbols and standards. Strength and design of welded joints under static and dynamic loading. Design of **eccentrically loaded welded joints** and weld group analysis. Advantages and limitations of welded joints.

Unit IV: Design of Springs

Definition and function of springs, Applications in engineering systems (suspension systems, valves, robotic actuators, vibration isolation), Types of springs: Helical springs (compression, tension, torsion)
Leaf springs, Spiral springs, Disc (Belleville) springs. Spring materials and their properties (high fatigue strength, resilience, corrosion resistance). Stress and deflection Analysis in Helical Springs, Springs Under Fatigue Loading. Nipping and pre-stressing phenomenon in leaf spring, Surface treatment (shot peening, coating) of springs.

Unit V: Design of Shafts and Keys

Design of Shafts: Definition and function of shafts, Classification: Transmission shafts (line shaft, counter shaft), Machine shafts (crankshaft, camshaft), Materials used for shafts and selection criteria, Standard shaft sizes and specifications. Types of loads acting on shafts: Torsional loads, Bending loads, Axial loads. Combined stresses due to bending and torsion, Shock and fatigue factors in shaft design, Stress concentration in shafts (steps, fillets, keyways). Design based on Strength criteria and Rigidity criteria.
Design of Keys: Function of keys in power transmission, Types of keys, applications and selection of keys. Failure modes of keys.

Text books:

1. V. B. Bhandari, Design **of Machine Elements,** McGraw Hill Education (India), 4th Edition.
2. Joseph E. Shigley & Charles R. Mischke **Mechanical Engineering Design,** McGraw Hill Education, 11th Edition

Reference Books:

1. M. F. Spotts & T. E. Shoup, **Design of Machine Elements,** Pearson Education
2. Design Data: Data Book of Engineers, PSG College of Technology, Coimbatore, Publisher:

Kalaikathir Achchagam, Coimbatore

V Semester
Department of Mechanical Engineering

Course Code : PCC 25ES04TP0503 Course : Heat Transfer
L: 3Hrs. T: 0 Hrs. P: 0 Hrs. Per week Total Credits : 03

Course Objectives

1. To understand basic of Heat Transfer Mechanisms governing laws and their applications in heat transfer analysis.

Course Outcomes

1. Understand and analyze basic modes of heat transfer and apply mathematical equations to analyse steady state heat conduction.
2. Analyze heat conduction with internal heat generation, extended surfaces and unsteady state heat transfer.
3. Demonstrate the concept and mechanism of forced convection for flow over flat plate, external, internal flows through conduits.
4. Understand the concept of natural convection, boiling and condensation.
5. Apply the basic laws of radiation heat transfer and their applications.
6. Analyse the performance practical applications of heat exchangers.

Syllabus

Unit –I: Introduction, Basic modes of Heat Transfer, Conduction, Convection and Radiation, Laws of Heat Transfer, General Heat conduction equation in Cartesian
Coordinates, Thermal conductivity and diffusivity, One dimensional steady state conduction equation for the plane wall, Cylinder and Sphere, Thermal resistance of composite structures, Contact resistance, overall heat transfer coefficient, critical thickness of insulation.
Unit – II: Conduction with internal heat generation for plane wall, Cylinder and sphere, Extended Surfaces, Types of Fins, Fins of uniform cross section area, temperature distribution and their heat transfer rate, Fin efficiency and effectiveness, Unsteady state Heat transfer, Lumped Heat Capacity analysis, Heisler charts, Biot number, Fourier number and their significance.
Unit – III : Forced convection, physical significance of non dimensional parameters, Flow of high, moderate and low Prandtl number fluid over flat surface, Concept of velocity and thermal boundary layer thickness, Local and average Heat Transfer coefficient, empirical co-relation for external, internal flow, Laminar and turbulent flow through conduits.
Unit – IV : Free or Natural Convection, Grashoff number, Rayleigh number, horizontal and vertical plate, empirical correlations for Cylinders and sphere, Heat transfer with phase change, pool boiling curve and regimes of pool boiling, film and drop wise condensation, Laminar film condensation on vertical surface, Film condensation on horizontal tubes
Unit - V : Radiation, nature of thermal radiation, black body radiation, radiation intensity, laws of radiation-Kirchoffs, Planks, Weins displacement, Stefen-Boltzmann and Lamberts Cosine law,

Emissivity, absorptivity, transmissivity, reflectivity, radiosity, emissive power, irradiation, Radiation network, radiation exchange between surfaces, idea of shape factor and reciprocity theorem, radiation between parallel plates, Cylinder and sphere, radiation shields, effect of radiation on temperature measurement.
Unit – VI : Heat exchanger : classification, overall heat transfer coefficient, Fouling factor, LMTD method of heat exchanger analysis, Analysis for parallel, counter flow and cross flow arrangement, effectiveness-NTU method, heat exchanger analysis by NTU method

Text Books

1. Heat and Mass transfer, Y. A. Cengel, McGraw Hill.
2. Kumar D. S., Heat Transfer, S K Kataria & Sons.
3. Kothandaraman C. P., Fundamentals of Heat & Mass Transfer, New Age Techno Press.

Reference Books

1. Holman J. P., Heat Transfer, Mc Graw Hill.
2. . M Tirumaleshwar, Fundamentals of Heat & Mass Transfer, Pearson.

Course Code	Course Title				Category
25ES04TP0504	**Instrumentation and Control**				PCC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	2	2	50	50	04

Prerequisite: Students should have a basic understanding of Mathematics, including algebra, trigonometry, and elementary calculus. They should be familiar with fundamental concepts of Physics such as electricity, magnetism, and basic mechanics. A foundational knowledge of electrical and electronic components like resistors, capacitors, and inductors, is essential. Students should also have basic knowledge of units.

Course Objectives:

1. To understand the measurement system and its various components.
2. To make students aware of a various sensor in the domain of engineering field 1.
3. To understand the automatic controls with feedback and to use it in models in various systems

Course Outcomes: The students will be able to,
CO1: Explain the fundamentals of measurement systems, classify instruments based on their characteristics, and describe the working principles of various transducers and sensors.
CO2: Compare and evaluate different sensors based on their operating principles, performance characteristics, advantages, and applications.
CO3: Analyz**e** measurement data and apply appropriate hardware and software tools for data acquisition and processing.
CO4: Explain and construct control system representations using block diagrams and signal flow graphs, and analyze system behavior.
CO5: Develop and analyze mathematical models of physical, mechanical, and electrical systems. *(*

UNIT I:	**8Hrs.**

Measurement Systems, generalized measurement system, static and dynamic characteristics of measurement systems, errors, Sensors and Industrial Instrumentation Resistive-, capacitive -, inductive- piezoelectric -, Hall effect sensors and associated signal conditioning circuits.

UNIT II:	**8Hrs.**

Sensors :Working principla,construction of displacement, velocity (Speed), acceleration, force, torque, vibration, pressure, temperature flow, liquid level and viscosity measurement sensors

UNIT III:	**8Hrs.**

Introduction to data acquisition,types of data acquisition systems elements of data acquisition systems, A-D D-A convertors, Signal conditioning.

UNIT IV:	**8Hrs.**

Introduction of control system and concept of transfer function, system representation through block diagram and signal flow graph, transfer function through block diagram simplification and Mason's Gain formula.

UNIT V:	**8Hrs.**

Mathematical Modelling of Physical Systems, mechanical system, electrical system, hydraulic systems, pneumatic system, thermal systems.

TEXT BOOKS:

1. Nakra B.C. and Chaudhary K.K., Instrumentation, Measurement and Analysis, Tata McGraw Hill.
2. Kumar D. S., Mechanical Measurements, Kataria & Sons.
3. Ogata, Modern Control Engineering, PHI Publications. Nagrath & Gopal, Control system, TMH Publicationss.

REFERENCE BOOKS:

1. Alan S. Morris, Principles of Measurement and Instrumentation, Prentice Hall of India.
2. Kuo B.C., Automatic control system, PHI Publications.
3. Ernest O. Doebelin, Measurement systems Application and Design, Tata McGraw Hill Edition.

Relevance of the Course for Higher Semester Subjects:

This course provide a crucial foundation for many advanced engineering subjects. The concepts of measurement, signal conditining and system control are essential for understanding higher-level courses such as process control, industrial automation, robotics, and mechatronics.
This course supports the study of advanced control systems.It is also highly relevant for subjects involving PLC,SCADA systems, which are widely used in modern industries.
Additionally, knowledge of instrumentation is vital in areas like power systems, manufacturing processes, and chemical engineering operations.

Course Code	**Course Title**				**Category**
25ES04TP0504	**Instrumentation and Control**				PSE
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	0	50	00	02
Prerequisite: Physics					

Course Objectives:
1. To verify the characteristics of different measuring instruments and devices.
2. To use sensors for the measurement of mechanical quantities.

Course Outcomes: The students will be able to,
CO1 :Perform laboratory experiments for the measurement of quantities such as pressure, temperature, flow, load, strain, angular and linear displacement, speed, light intensity etc.
CO2: Identify, formulate, and solve signal conditioning problems by applying principles of different measurement system.
CO3: Estimate the uncertainty of an experimental result from the experimental errors associated with the data and find out the accuracy of the instruments and write the conclusions about the experiments using the obtained result.
CO4: Use of hardware and software for acquisition of data

List of Experiments:
The laboratory will have minimum Ten Practical based on the syllabus of

1. Calibration of Pressure Gauges Using Dead Weight Pressure Gauge Tester
2. Angular Displacement Measurement Using Variable Capacitive Transducer
3. Linear Displacement Measurement Using Inductive Pick Up
4. Force Measurement Using Load Cell
5. Speed Measurement Using Inductive and Optical Transducer
6. Pressure Measurement Using Piezo-Resistive Pressure Sensor
7. Displacement Measurement Using LVDT.
8. Pressure Measurement Using Bourdon Tube 'C' Type With LVDT
9. Vibrations Measurement Using Piezo-Resistive Transducer
10. Light Intensity Measurement Using LDR
11. Torque Measurement Using Strain Gauges and Cantilever Jig

Strain/Force Measurement Using Strain Gauge Mounted on Cantilever Beam

13. Temperature Measurement Using Radiation Pyrometer
14. Humidity Measurement Using Capacitive Transducer For 90% R H Non Condensed
15. Measurement of Speed Of Wind Using Digital Anemometer
16. Introduction to Sound and vibration suit with portable DAQ.

VI SEMESTER SYLLABUS

Course Code	**Course Title**		**Category**
24ES04TH0603	**Operations Research**		**Regular**
Contact Hours per Week	**CA**	**FE**	**Credits**

L	P	S			
03	**00**	**02**	**50**	**50**	**03**

Prerequisite: Engineering Mathematics, Probability and Statistics, Production Planning and Control basics.

Course Objectives:
The objectives of this course are: To enable students to formulate and solve engineering and industrial decision-making problems using Operations Research techniques for optimal resource utilization, cost minimization, productivity improvement, and effective planning and control.

Course Outcomes
On successful completion of the module, students will be able to:
CO1: Describe the basic concepts, scope, methodology, and applications of Operations Research in mechanical engineering systems.
CO2: Formulate and solve linear programming problems using graphical and simplex methods.
CO3: Apply transportation and assignment models for optimal allocation of resources.
CO4: Analyze sequencing, inventory, and replacement problems for manufacturing and service systems.
CO5: Apply project scheduling, queuing theory, and decision theory techniques for industrial decision-making.

UNIT I: INTRODUCTION TO OPERATIONS RESEARCH AND LINEAR PROGRAMMING	**06 Hrs.**

Definition, meaning, scope, and applications of Operations Research, characteristics and limitations of Operations Research, phases of Operations Research study, role of Operations Research in mechanical engineering, production planning, maintenance, inventory, project management, and industrial systems.
Linear Programming Problem: formulation of LPP, assumptions of LPP, mathematical model of LPP, objective function and constraints, graphical method for two-variable problems, special cases: multiple solution, infeasible solution, and unbounded solution.

UNIT II: SIMPLEX METHOD AND DUALITY	**06 Hrs.**

Standard form of Linear Programming Problem, slack variables, surplus variables and artificial variables, simplex method for maximization and minimization problems, Big-M method, Two-Phase method, concept of duality, primal-dual relationship, economic interpretation of dual variables, basic concept of sensitivity analysis.

UNIT III: TRANSPORTATION AND ASSIGNMENT PROBLEMS	**09 Hrs.**

Transportation Problem: mathematical formulation, balanced and unbalanced transportation problems, initial basic feasible solution using North-West Corner Method, Least Cost Method, and Vogel's Approximation Method, optimality test using MODI method, degeneracy in transportation problem.
Assignment Problem: mathematical formulation, Hungarian method, minimization and maximization assignment problems, unbalanced assignment problem, travelling salesman problem: basic concept and applications.

UNIT IV: SEQUENCING, INVENTORY AND REPLACEMENT MODELS	**09 Hrs.**

Sequencing Problems: processing of jobs through machines, n jobs through 2 machines, n jobs through 3 machines, 2 jobs through m machines, applications in production scheduling and manufacturing systems.
Inventory Control: meaning and importance of inventory, types of inventory, inventory costs, Economic Order Quantity model, EOQ model with and without shortages, reorder level, safety stock, ABC analysis.
Replacement Models: replacement of items that deteriorate with time, replacement of items that fail suddenly, individual and group replacement policies, applications in maintenance management.

UNIT V: PROJECT SCHEDULING, QUEUING THEORY AND DECISION THEORY	**09 Hrs.**

Project Scheduling: network construction, Critical Path Method, Program Evaluation and Review Technique, earliest start time, latest start time, earliest finish time, latest finish time, float and slack, project crashing: basic concept.
Queuing Theory: introduction to waiting line models, elements of queuing system, arrival rate, service rate, single-server queuing model, applications in maintenance, service centres, machine repair, and production systems.
Decision Theory: decision-making under certainty, risk, and uncertainty, maximax, maximin, minimax regret, Laplace and Hurwicz criteria, Expected Monetary Value, decision tree: basic concept.

TEXT BOOKS:

1. P. K. Gupta and D. S. Hira, *Operations Research*, 7th Edition, S. Chand Publishing, New Delhi, 2022.
2. Hamdy A. Taha, *Operations Research: An Introduction*, 11th Edition, Pearson Education, 2023.
3. Kanti Swarup, P. K. Gupta and Man Mohan, *Operations Research*, 20th Revised Edition, Sultan Chand & Sons, New Delhi, 2022.

REFERENCE BOOKS

1. J. K. Sharma, *Operations Research: Theory and Applications*, 6th Edition, Macmillan Publishers India, 2020.
2. R. Panneerselvam, *Operations Research*, 3rd Edition, PHI Learning Pvt. Ltd., New Delhi, 2023.
3. N. D. Vohra and Hitesh Arora, *Quantitative Techniques in Management*, 6th Edition, McGraw Hill Education, 2021.
4. S. D. Sharma, *Operations Research*, Revised Edition, Kedar Nath Ram Nath & Co., Meerut.
5. Frederick S. Hillier and Gerald J. Lieberman, *Introduction to Operations Research*, 11th Edition, McGraw Hill Education, 2021.
6. A. Ravindran, Don T. Phillips and James J. Solberg, *Operations Research: Principles and Practice*, 2nd Edition, John Wiley & Sons / Wiley India, 1987 / 2007 Indian Reprint.
7. Wayne L. Winston, *Operations Research: Applications and Algorithms*, 3rd Revised Edition, Duxbury Press, Belmont, California, 1994.
8. V. K. Kapoor, *Operations Research*, Sultan Chand & Sons, New Delhi, 2014.

Course Code	**Course Title**					**Category**
26ES04TP0602	**CAD & FEA**					PSE/PEC
Contact Hours per Week				**CA**	**ESE**	**Credits**
L	**P**	**S**	Credits			
3	2	2	4	50+50	50	3

Prerequisite: Engineering Mathematics, Engineering Graphics & Machine Drawing, Mechanics of Materials / Strength of Materials, Heat Transfer, Fluid Mechanics

Course Objectives: The objective of the course is to prepare the students

1. To provide foundational knowledge of computer graphics, transformation matrices, and parametric modeling approaches for precise CAD representation.
2. To enable students to formulate and solve engineering problems using Finite Element Method (FEM) applied to structural, thermal, and fluid flow networks

Course Outcomes: After completing this course, students will be able to:
CO1: Apply computer graphics fundamentals and transformations to represent engineering components.
CO2: Construct parametric curves and surfaces to support precise CAD modeling requirements.
CO3: Formulate 1D engineering problems using weighted residual methods and axial bar FEM concepts.
CO4: Model and analyze truss structures and derive higher-order shape functions.
CO5: Solve thermal and fluid flow problems using FEM and interpret results for industrial applications.

Unit-1: CAD & Computer Graphics
Computer graphics fundamentals: Raster Scan Graphics, Coordinate systems, Transformations of Geometries, Translation, rotation, scaling, Reflection and shear, Homogeneous coordinate system, Composite transformations, Matrix representation of transformations, 3D transformation matrices, Windowing and clipping concepts, Geometric modeling, Wireframe modeling,

Unit-2: Parametric Curves and Surfaces
Parametric curves: Mathematical representation of curves, Parametric form of curves, Differential geometry of curves Bezier and B-Spline curves; Parametric surfaces, Surface continuity and smoothness, Practical relevance in CAD modeling

Unit-3: Weighted Residuals & 1D FEM
Approximate solution of differential equations, Weighted residual concept.
Methods: Point Collocation Method, Sub-domain Method, Least Squares Method, Galerkin Method
Application to 1D second-order differential equations, Imposition of boundary conditions
Solution of 1D problems using polynomial approximations, Error estimation and convergence basics
Axial bar element: EME, Assembly-GME, Stepped and composite bars, Multi-material bar systems,
Solution for: Nodal displacements, Element stresses, Support reaction

Unit-4: Trusses & Shape Functions
Truss elements: Two-force members, Direction cosines, Global stiffness formulation, Deflection analysis in truss elements
Properties of shape functions, Lagrange's shape functions, Linear and quadratic shape functions

Unit 5: Thermal & Fluid Flow FEM
1-D steady-state heat conduction, Composite walls, Temperature distribution using FEM,
Fluid Flow: FEM formulation for fluid flow networks, Primary variables (pressure, flow rate), Element matrix equation (EME), Assembly of global flow matrix, Solution of flow networks with specified boundary conditions

TEXT BOOKS:

1. CAD/CAM Principles and Applications – J. Srinivas (Oxford).
2. Computer Graphics – Donald Hearn & M. Pauline Baker.
3. The Finite Element Method in Engineering – S. S. Rao.
4. An Introduction to the Finite Element Method – J. N. Reddy

REFERENCE BOOKS:

1. CAD/CAM Concepts and Applications – C. R. Alavala.
2. Finite Element Analysis – S. S. Bhavikatti (New Age).
3. Introduction to Finite Elements in Engineering – Chandrupatla & Belegundu.

Additional Resources:

CO–PO AND CO–PSO ARTICULATION MATRIX

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering
Session: 2026-27

Course Outcomes	Engineering knowledge	Problem Analysis	Design/ Development of Solutions	Conduct Investigation of Complex Problems	Modern Tools Usage	The Engineer and Society	Ethics	Individual and Team Work	Communication	Project Management and Finance	Life Long Learning	Design Production Interdisciplinary	Analysis-Computer Sol
	1	2	3	4	5	6	7	8	9	10	11	1	2
CO1	3	2	1	1	3	-	-	-	1			3	2
CO2	2	3	2	1	3	-	-	-	1			3	2
CO3	3	3	2	2	2	-	-	-	1			3	3
CO4	3	3	2	3	2	-	-	-	1	1	1	3	3
CO5	3	3	2	3	3	1	1		1	1	2	3	3
Target Level	2.1	2.1	2.1	2.1	2.1	-	-	2.1	2.1	2.1	2.1	2.1	2.1
Correlation	3 : High			1 : Low			– : No Correlation						

Scale: 3 = Strong, 2 = Moderate, 1 = Slight, – = No Relation

MODE OF CONDUCTION AND EVALUATION (CONTINUOUS EVALUATION – 50 MARKS)

Component	Mode of Conduction	Marks	COs Assessed
Mid-Semester Examination (MSE)	Written exam – all theory (Units 1–3); MCQ + Short Answers + Problems	30 Marks	CO1, CO2, CO3
Teacher's Assessment (TA)	2 Assignments + 1 Surprise Quiz + Attendance/Regularity	20 Marks	CO1–CO5
Lab Internal Assessment	Lab record, experiment performance, viva-voce (per experiment)	25 Marks	CO1–CO5
End-Semester Examination (ESE)	3-hour written exam – all 5 units; Theory portion	50 Marks	CO1–CO5
Lab End-Semester Examination	Practical examination: one experiment + mini-project demo + viva	25 Marks	CO4, CO5

Theory Internal (50 Marks) = Mid-Semester Exam (30) + Teacher's Assessment (20)
Theory External (50 Marks) = End-Semester Exam (3 Hours, covering all 5 units)
Lab Internal (25 Marks) = Lab Record (10) + Experiment Performance & Viva (10) + Attendance/Regularity (5)
Lab External (25 Marks) = Practical Exam (1 Experiment, 15) + Mini-Project Demo (5) + Viva Voce (5)

Course Code	**Course Title**					**Category**
26ES04TP0602	**CAD & FEA**					PSE/PEC
Contact Hours per Week				**CA**	**ESE**	**Credits**
L	**P**	**S**	Credits			
3	2	2	4	50+50	50	3

Prerequisite: Engineering Mathematics, Engineering Graphics & Machine Drawing, Mechanics of Materials / Strength of Materials, Heat Transfer, Fluid Mechanics

Course Objectives: The objective of the course is to prepare the students

3. To provide foundational knowledge of computer graphics, transformation matrices, and parametric modeling approaches for precise CAD representation.
4. To enable students to formulate and solve engineering problems using Finite Element Method (FEM) applied to structural, thermal, and fluid flow networks

Course Outcomes: After completing this course, students will be able to:

CO1: Apply computer graphics fundamentals and transformations to represent engineering components.
CO2: Construct parametric curves and surfaces to support precise CAD modeling requirements.
CO3: Formulate 1D engineering problems using weighted residual methods and axial bar FEM concepts.
CO4: Model and analyze truss structures and derive higher-order shape functions.
CO5: Solve thermal and fluid flow problems using FEM and interpret results for industrial applications.

List of Experiments

Lab/Practical: 12 Experiments

1. **Transformation Logic:** C/Python program for 2D/3D transformations of a geometry.
2. **Curve Implementation:** Implementation of Bezier curve algorithms.
3. **Part Modeling:** Advanced parametric solid modeling using **CATIA**.
4. **1D Bar Analysis:** Stress and strain analysis of a stepped bar in **Abaqus**.
5. **Weighted Residuals:** Solving 1D differential equations using the Galerkin method.
6. **Truss Analysis:** Deflection and force analysis of a 2D truss in **ANSYS**.
7. **Beam Simulation:** 3D Beam bending and shear force analysis using **Nastran-Patran**.
8. **Thermal Analysis:** 1D Heat conduction through composite walls using **ANSYS**.
9. **Fluid Networks:** Modeling a fluid flow network and solving for pressure in **SolidWorks Flow**.
10. **Structural Assembly:** Bolt/Fastener contact stress analysis in **Abaqus**.
11. **Convergence Study:** Analyzing the effect of mesh refinement on stress results.
12. **Capstone Project:** Full simulation of a mechanical component (e.g., Brake disc or Airfoil)

Course Code	25ES04TP0603	Program	B.Tech. ME
Course Name	Applied Thermal Engineering	Acad. Year	
Course Coordinator	S. A. Patil	Semester	VI
Credits	4	Section	-
Contact Hours	3 hours/week	Type	Program Core Course

Teaching and Examination Scheme:

SN	Code	Course	Teaching Scheme			Credits	Maximum Marks			Exam Dura-tion	Nature of Course
			L	T	P		Total	End Sem Exam	Internal Assessment		
1	25ES04TP0603	Applied Thermal Engineering	3	0	2	4	100	50	50	3 Hrs.	

Course Outcomes:

After successful completion of this course, the student will be able to,
CO1: Analyze performance of reciprocating compressors.
CO2: Explain working and performance of rotary and dynamic compressors.
CO3: Analyze working and performance of internal combustion engines.
CO4: Apply refrigeration and psychrometric principles to air-conditioning systems.
CO5: Describe the working and basic performance of gas turbines and jet propulsion systems.

Course Contents:

UNIT – I: Positive Displacement Compressors (07 Hrs)
Classification of compressors.
Reciprocating Compressors: Construction, Working principle, Work done during Isothermal, Polytropic compression, Adiabatic compression processes, Isothermal efficiency, Effect of clearance volume, Volumetric efficiency, Mechanical efficiency. Multistage compressors: Advantages, Condition for minimum work input, Capacity control methods, Actual indicator diagram
UNIT – II: Rotary and Dynamic Compressors (07Hrs)
Rotary Compressors: Roots blower, Rotary vane compressor, Screw compressor Principle, construction, working, Indicator diagram, Work done, Roots efficiency and vane efficiency
Dynamic Compressors:
Centrifugal Compressor Principle and construction, Velocity diagrams, Static and total head, Work done by impeller, Isentropic efficiency, Slip factor, Pressure coefficient, Power input factor
Axial Flow Compressor Principle and construction, Velocity diagram, Work done, Degree of reaction, Stage efficiency, Compressor characteristics, Surging and choking, Polytropic efficiency
UNIT – III: Internal Combustion Engines (07 Hrs)
Classification of I.C. engines, Parts and working of I.C. engines, Two-stroke and four-stroke engines, SI and CI engines, Air-standard and fuel-air cycles
Introduction to combustion: SI engine combustion, CI engine combustion
Carburetion and fuel injection systems
I.C. Engine Testing Measurement: Indicated power, Brake power Friction power, Speed, Fuel consumption, Air consumption
Performance parameters: Indicated thermal efficiency, Brake thermal efficiency, Mechanical

efficiency, Volumetric efficiency, Percentage of excess air, Heat balance sheet

UNIT – IV: Refrigeration and Air Conditioning (08Hrs)

Refrigeration: Unit of refrigeration, Simple vapour compression refrigeration system, Alternative refrigerants, Introduction to cryogenics and applications

Air Conditioning: Psychrometric properties, Psychrometric processes, Human comfort and factors affecting comfort, Bypass factor, Application of psychrometrics to simple air-conditioning systems

UNIT – V: Gas Turbines and Jet Propulsion (08Hrs)

Gas Turbines: Ideal gas turbine cycles, Isentropic efficiency and small stage efficiency, Applications of gas turbines, Pressure losses, Effect of: Intercooling, Reheating, Regeneration, Fuel–air ratio, Combustion efficiency, Performance calculations, Open cycle and closed cycle gas turbine plants, Cogeneration and combined power cycles

Jet Propulsion:

Principles and working of: Turbojet, Turboprop, Ramjet, Pulse jet, Simple turbojet cycle, Thrust power and propulsive power, Thermal efficiency, Propulsive efficiency, Overall efficiency

Text books:

1) Rajput R.K., Thermal Engineering, Laxmi publications.
2) Mahesh Rathore, Thermal Engineering, Mc-Graw Hill pub.
3) Ganesan V., Internal Combustion Engines, Mc-Graw Hill pub.

Reference Books:

1) Cohen & Rogers, Gas Turbine Theory, Longmans Green pub.
2) Charles Fayette Taylor, The Internal Combustion Engine in Theory and Practice Volume I & II, The MIT Press.
3) Khajuria & Dubey, Gas turbine & Jet Propulsion, Dhanpat rai & sons.

Laboratory Course:

Course Objectives:

To enable students to experimentally evaluate the performance of various thermal systems.
To develop the ability to analyze and interpret experimental data obtained from thermal systems.
To gain practical understanding of gas turbines and jet propulsion systems.

Course Outcomes:

After successful completion of this course, the student will be able to,
CO1: Evaluate the performance of reciprocating compressors and internal combustion engines through experimental testing.
CO2: Analyze engine performance characteristics and the effect of compression ratio variation on operating parameters.
CO3: Determine the performance parameters of refrigeration and air conditioning systems.
CO4: Explain the working principles and components of gas turbine plants and jet propulsion systems.

List of Practical:

1. To evaluate the volumetric and isothermal efficiencies of a reciprocating air compressor test rig.
2. To study the components of internal combustion engines and compare S.I. and C.I. engines, as well as 2-stroke and 4-stroke engines.
3. To perform a performance test on a single-cylinder petrol engine test rig.
4. To perform a performance test on a single-cylinder diesel engine test rig.

5. To analyze the effect of variation in compression ratio on the operating parameters of a variable compression ratio petrol engine setup.
6. To determine the coefficient of performance (COP) of a computerized vapour compression refrigeration test rig.
7. To evaluate the performance of different psychrometric processes using an air conditioning test rig.
8. To study the working of various gas turbine plants.
9. To study the principles and types of various jet propulsion systems.

Course Code	Course Title				Category
25ES04PR0604	**Product Innovation and Entrepreneurship Lab**				PCC/IDE
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**T**	**D/P**			
00	00	04	25	25	02

Prerequisite: Basic Engineering Design, Innovation Thinking

Course Objectives:

1. To apply design thinking principles to identify and define real-world problems in Robotics & AI domains.
2. To develop and validate innovative product concepts through idea generation, screening techniques (scoring matrix, Pugh Matrix), and Technology Readiness Level (TRL).
3. To design and build functional prototypes using appropriate hardware, software, and integration tools relevant to Robotics & AI.
4. To analyze basic business models and prepare pitch-ready solutions addressing market needs and feasibility.

Course Outcomes: On successful completion of the module students will be able to:
CO1: Identify and analyze real-world problems and generate innovative product ideas using structured design thinking approaches.
CO2: Evaluate and select feasible concepts using idea screening methods such as scoring matrix, Pugh Matrix, and TRL.
CO3: Develop and demonstrate working prototypes integrating mechanical, electronic, and AI components.
CO4: Prepare and present a structured pitch including product, market, and business model for the proposed solution.

Expt. 1: Problem Identification and Need Analysis
Identification of real-world problems in Robotics & AI domain and formulation of problem statement.

Expt. 2:User Research and Survey Analysis
Design and conduct surveys/interviews to understand user needs and analyze collected data.

Expt. 3:Idea Generation Techniques
Application of brainstorming and SCAMPER techniques to generate multiple solution ideas.

Expt. 4:Concept Screening using Weighted Scoring Matrix
Evaluation and ranking of ideas based on defined criteria.

Expt. 5:Concept Selection using Pugh Matrix
Comparison of alternative concepts with a reference using + / – / 0 method.

Expt. 6:Technology Readiness Level (TRL) Assessment
Determination of maturity level of selected concept and analysis of associated risks.

Expt. 7:Concept Design
Development of design concepts using CAD models.

Expt. 8:Prototype Development (Minimum Viable Product)
Development of basic working prototype using suitable tools, hardware, and software.

Expt. 9: Testing, Validation and Iteration
Performance testing of prototype and implementation of design improvements.

Expt. 10: Business Model Canvas (BMC) Development
Preparation of BMC including customer segments, value proposition, and revenue streams.

Expt. 11: Cost Estimation and Market Analysis
Preparation of basic Bill of Materials (BOM), cost estimation, and identification of target market.

Expt. 12: Pitch Deck Preparation and Presentation
Development and presentation of pitch deck covering problem, solution, product, and business model.

VIII SEMESTER

Course Code	**Course Title**				**Category**
26ES04TH0801	**Project Management**				**Regular**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	**00**	**02**	**50**	**50**	**03**
Prerequisite:					

Course Objectives:

The Objectives of this course is;

To enable students to understand and apply project management principles, tools, and techniques for effective planning, scheduling, execution, monitoring, control, risk management, and successful completion of engineering and industrial projects.

Course Outcomes: On successful completion of the module students will be able to:

CO1: Describe the fundamentals, phases, types, life cycle, and multidisciplinary applications of project management.

CO2: Develop detailed project plans including scope, schedule, resources, stakeholder requirements, and deliverables.

CO3: Analyze project cost, budgeting, financing, risk factors, and sustainability considerations using standard project management techniques.

CO4: Apply quality control, risk mitigation, communication, teamwork, and ethical practices during project execution.

CO5: Monitor and evaluate project performance using project management tools, digital platforms, and key performance indicators.

UNIT I: INTRODUCTION TO PROJECT MANAGEMENT	**09 Hrs.**

Definition of project and project management, Project life cycle phases, Types of projects, Characteristics of successful projects, Role of project manager, Project selection methods, Feasibility analysis, Project charter, Organizational structures, Project stakeholders, Ethics in Project Management.

UNIT II: PROJECT PLANNING AND SCHEDULING	**09 Hrs.**

Project scope definition, Work Breakdown Structure (WBS), Project time management, Gantt chart, Network diagrams, Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), Milestone planning, Time-cost trade-offs, Resource allocation and levelling, AI tools in project planning.

UNIT III: PROJECT COSTING AND BUDGETING	**09 Hrs.**

Cost estimation techniques, Project budgeting methods, Cost baseline, Earned Value Management (EVM), Project cash flows, Financial analysis: NPV, IRR, Payback period, Break-even analysis, Cost control methods.

UNIT IV: PROJECT QUALITY AND RISK MANAGEMENT	**06 Hrs.**

Project quality planning, Quality assurance and control, Six Sigma in project management, Risk identification and classification, Qualitative and quantitative risk analysis, Risk response planning, Contingency planning, Risk monitoring and control, Lifecycle assessment and Environmental impact assessment.

UNIT V: PROJECT MONITORING, CONTROL, AND CLOSURE	**06 Hrs.**

Monitoring and control processes, Key performance indicators (KPIs), Project audits, Conflict resolution, Change management, Generative AI for documentation & reporting, Project evaluation and termination, Post-project review, Lessons learned, Project management software tools (MS Project, Power BI, Primavera)

TEXT BOOKS:

- Harold Kerzner, *Project Management: A Systems Approach to Planning, Scheduling, and Controlling*, 14th Edition, John Wiley & Sons, 2025.
- Prasanna Chandra, *Projects: Planning, Analysis, Selection, Financing, Implementation and Review*, 10th Edition, McGraw Hill Education India, 2024.
- K. Nagarajan, *Project Management*, 8th Edition, New Age International Publishers, New Delhi, 2017.
- S. Choudhury, *Project Management*, McGraw Hill Education / Tata McGraw Hill, New Delhi, 2017.
- P. Gopalakrishnan and V. E. Rama Moorthy, *Textbook of Project Management*, First Edition, Laxmi Publications, New Delhi, 2022.
- Vasant Desai, *Project Management and Entrepreneurship*, Second Edition, Himalaya Publishing House, Mumbai, 2017.
- R. Panneerselvam and P. Senthilkumar, *Project Management*, PHI Learning Pvt. Ltd., New Delhi, 2009.
- K. K. Chitkara, *Construction Project Management: Planning, Scheduling and Controlling*, 4th Edition, McGraw Hill Education India, 2019.
- B. C. Punmia and K. K. Khandelwal, *Project Planning and Control with PERT and CPM*, 4th Edition, Laxmi Publications Pvt. Ltd., New Delhi, 2023/2024.
- N. K. Jain, *Project Planning and Control*, Sanjeev Prakashan, 2018.

REFERENCE BOOKS

- M. R. Gopalan, *Project Management: Core Textbook*, 2nd Indian Edition, Wiley India Pvt. Ltd., New Delhi, 2014.
- Rory Burke, *Project Management: Planning and Control Techniques*, 5th Edition, John Wiley

& Sons, 2013.

- Project Management Institute, *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, 8th Edition, Project Management Institute, 2025.

Course Code	Course Title				Category
26ES03TH0802/ 25ES04TH0802	**Research Methodology Semester VIII**				**PCC**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
2	**0**	**2**	**50**	**50**	**02**

Prerequisite:
Basic understanding of undergraduate-level subjects, fundamental mathematics/statistics, and general academic writing skills. Familiarity with computers and basic research concepts will be helpful.

Course objectives:
Students should be able

1. To introduce the fundamentals of research methodology, research process, and techniques of scientific inquiry.
2. To develop skills in identifying research problems, reviewing literature, and designing research methodology.
3. To familiarize students with various methods of data collection, analysis, and interpretation.
4. To create awareness about ethics in research paper writing
5. To enable students to understand Intellectual Property Rights (IPR), patents, copyrights, its evolution, significance and their applications in innovation.

Course Outcomes:
At the end of the course the student will be able to:
CO1: Understand the basic concepts, process, and importance of research methodology in academic and industrial research.
CO2: Formulate research problems, conduct literature reviews, and prepare structured research proposals.
CO3: Apply suitable methods of data collection, analysis, and interpretation to solve research problems.
CO4: Choose research topics, write structured research papers and adhere to plagiarism rules and ethical standards.
CO5: Understand the procedures for patent filing, copyright, and trademark registration, and apply IPR concepts in real-life case studies.

COURSE CONTENTS

Unit I: Introduction to Research Methodology	**08 hours**

Meaning of Research, How to do Research, Objective of Research, Motivation in Research, Types of Research, Various Research Approaches and Significance of Research. Research Methods and Research Methodology.

Unit II: Research Problem and Literature Review	**07 hours**

Research Problem, Various Components of Research Problem, How to Identify the Research Problem, Necessity and Techniques involved in Defining Research Problem, Feasibility Check. Meaning and Importance of Literature Review, Sources of literature, Role in identifying Research Gaps and Framing Research Problem.

Unit III: Data Collection and Analysis	**07 hours**

Hypothesis, its Characteristics, Examples, Types, Hypothesis Testing, Concepts and Procedure of Hypothesis Testing. Data Collection, Methods of data collection, Primary Data, Secondary Data, Analysis of data, Simple regression, Multiple regression, linear and non-linear correlation and regression.

Unit IV: Ethics in Research	**07 hours**

Research Paper and its contents, Choice on topic, Method of writing research paper, Ethics in Research, Plagiarism including rules of Plagiarism. Citation and Referencing Styles, Structure of a Research Report/Paper. Case studies of Research Papers in Science and Engineering. Presentation of Research Work.

Unit V: Introduction to Intellectual Property Rights (IPR)	**07 hours**

Introduction to IPR, Types of IPR, Common rules of IPR Practices, Patent Filing Procedure and Licensing Process. Case studies of Patents in Science and Engineering.

Text Books:

1. Research Methodology Methods and Techniques: Kothari C.K. (2004), New Age International, New Delhi
2. Simulation Modeling and Analysis, Law, A. M., and W. D. Kelton, 1991, McGraw Hill
3. Applied Statistics; Probability for Engineers: Montgomery, Douglas C.; Runger, George C. (2007), (Wiley India)
4. Patents myths and reality, Shiva, V., Penguin Books India (P) Ltd., New Delhi

Reference Books:

1. Schaum's Quick Guide to Writing Great Research Papers: Laurie Rozakis, 2nd edition, McGraw.
2. Intellectual Property Rights:Text And Cases, Radhakrishnan , R. &Balsubramaian, S., Excel Books Publishers, New Delhi.
3. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
4. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2012.
5. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", December 2018.

Relevance of the Course for Program (RAI & Mechanical Engineering)

1. Develops research and analytical skills for solving engineering and industrial problems.
2. Helps in designing experiments, data analysis, and validation of results.
3. Supports innovation, project work, and development of new technologies.
4. Enhances technical writing, documentation, and publication skills.

Course Code	Course Title				Category
26HS02TH0205	Foundational Literature of Indian Civilization				Regular
Contact Hours per Week			CA	FE	Credits
L	P	S			
01	00	01	50	-	01

Prerequisite: Robotics fundamentals

Course Objectives:

1. To introduce the intellectual and cultural foundations of Indian civilization through its classical literature.
2. To explore human values, ethics, and social structures in early Indian texts.
3. To understand the evolution of language, aesthetics, and philosophy in ancient literary traditions.
4. To examine historical, political, and pedagogical ideas in ancient Indian treatises.
5. To develop analytical skills to interpret classical texts in a non-theological, cultural context.

Course Outcomes:

6. CO1: Identify major classical Indian texts and describe their historical and intellectual contexts.
7. CO2: Analyze ancient literary sources as expressions of ethical, aesthetic, and social ideas.
8. CO3: Compare diverse schools of thought in early Indian literature with critical reasoning.
9. CO4: Evaluate contributions of classical literature to knowledge systems and societal frameworks.
10. CO5: Reflect on the relevance of foundational Indian ideas in a contemporary, globalized society.

UNIT I: LITERARY AND KNOWLEDGE TRADITIONS OF EARLY INDIA	**06 Hrs.**

Oral and textual traditions, Vedic corpus: Rigveda and later texts, Development of Sanskrit and Prakrit, Transition from ritual to philosophy, Early Indian cosmology and nature inquiry, Concepts of knowledge (Vidya), Logic and debate culture, Linguistic heritage and grammar (Panini)

UNIT II: THE EPICS AS CULTURAL NARRATIVES	**06 Hrs.**

Mahabharata and Ramayana as cultural and ethical texts, Narrative complexity and character dilemmas, Ideas of duty, leadership, justice, and statecraft, Dialogue as a method of moral reflection, Gender and family structures, Representation of conflict and resolution, Literary significance and performance traditions

UNIT III: CLASSICAL DRAMA, POETRY, AND PROSE	**06 Hrs.**

Kalidasa's Abhijnanasakuntalam and Meghadutam: aesthetics, language, nature, and emotions, Natyashastra: theory of aesthetics and dramatic structure, Panchatantra and fables as educational tools, Kavya literature and courtly culture, Rasa theory and literary criticism, Role of art and

imagination in public life

UNIT IV: ETHICAL AND POLITICAL THOUGHT IN TREATISES	**06 Hrs.**

Kautilya's Arthashastra: governance, economy, social policy, Manusmriti: legal codes, civil order (analyzed critically), Thirukkural: virtue, wealth, and conduct, Early legal and political systems, Comparative analysis of normative ethics in classical India

UNIT V: HUMAN VALUES, EDUCATION, AND KNOWLEDGE SYSTEMS	**06 Hrs.**

Concepts of education and learning in ancient institutions (Nalanda, Takshashila), Teacher-student relationships, Multilingual literary cultures, Knowledge dissemination methods, Dialogues from classical literature reflecting moral dilemmas, Relevance to modern human values and intercultural dialogue

REFERENCE BOOKS

1. G.N. Devy – Indian Literary Criticism: Theory and Interpretation, Orient Blackswan
2. Radhakrishnan and Charles Moore – A Sourcebook in Indian Philosophy, Princeton University Press
3. Sheldon Pollock (Ed.) – Literary Cultures in History: Reconstructions from South Asia, University of California Press
4. Romila Thapar – Cultural Pasts: Essays in Early Indian History, Oxford University Press
5. A.L. Basham – The Wonder That Was India, Picador India

Programme Specific Elective Syllabus

Renewable Energy Systems (PSE)

Course Code Course: 26ESPSE04TH0505-2

Contact Hours per Week

L	P	S	CA	FE	Credits
3	0	2	50	50	3

Prerequisites:

Students should possess:

1. Basic knowledge of Engineering Physics and Environmental Science.
2. Basic understanding of Thermodynamics and Heat Transfer.

3. Awareness of global energy demand and sustainability concepts.

Course Objectives

The objective of this course is:

1. To provide knowledge of renewable energy resources and their significance in sustainable development.
2. To understand the principles and technologies of solar, wind, biomass, geothermal, and small hydro energy systems.
3. To analyze the performance, economics, and environmental impact of renewable energy systems.
4. To develop skills in designing and evaluating renewable energy systems for engineering applications.
5. To introduce emerging renewable energy technologies and smart energy management practices.

Course Outcomes

On successful completion of the course, the students will be able to:

CO1: Explain various renewable energy resources and evaluate their potential for sustainable energy generation.
CO2: Analyze the working principles, components, and performance of solar energy conversion systems.
CO3: Evaluate wind energy systems and estimate power generation potential under varying operating conditions.
CO4: Apply principles of biomass, geothermal, and small hydro energy systems for practical energy applications.
CO5: Assess techno-economic feasibility and environmental impacts of renewable energy projects.
CO6: Design and simulate renewable energy systems using modern engineering tools and software.

UNIT I: Introduction to Renewable Energy Sources 7 Hours

Global energy scenario and energy challenges.
Need for renewable energy resources.
Classification of renewable energy sources.
Energy conservation and sustainability.
Potential of renewable energy resources in India.
Policies, incentives, and government initiatives.
Overview of renewable energy technologies.

UNIT II: Solar Energy Systems 8 Hours

Solar radiation fundamentals.
Solar geometry and measurement.
Solar thermal energy systems.
Solar water heaters.
Solar dryers.
Solar cookers.
Solar photovoltaic systems.
PV cells, modules, arrays.
Grid-connected and standalone solar systems.

Performance analysis and applications.

UNIT III: Wind Energy Systems 7 Hours

Wind characteristics and measurement.
Wind energy conversion principles.
Horizontal and vertical axis wind turbines.
Power coefficient and Betz limit.
Wind farm design.
Site selection criteria.
Performance evaluation and applications.
Offshore wind energy systems.

UNIT IV: Biomass, Geothermal and Small Hydro Energy 8 Hours

Biomass resources and conversion technologies.
Biogas plants and biodiesel production.
Waste-to-energy technologies.
Geothermal energy resources and applications.
Small hydro power plants.
Micro and mini hydro systems.
Environmental aspects and feasibility analysis.

UNIT V: Emerging Renewable Energy Technologies and Energy Management 8 Hours

Hydrogen energy systems.
Fuel cells and applications.
Ocean energy (tidal, wave, OTEC).
Hybrid renewable energy systems.
Energy storage technologies.
Smart grids and energy management.
Economic analysis of renewable energy projects.
Life cycle assessment and sustainability evaluation.

Textbooks

1. G. D. Rai, **Non-Conventional Energy Sources**, Khanna Publishers, New Delhi.
2. B. H. Khan, **Non-Conventional Energy Resources**, McGraw Hill Education.
3. S. P. Sukhatme and J. K. Nayak, **Solar Energy: Principles of Thermal Collection and Storage**, McGraw Hill Education.

References

1. Twidell, J. and Weir, T., **Renewable Energy Resources**, Routledge Publications.
2. Duffie, J. A. and Beckman, W. A., **Solar Engineering of Thermal Processes**, Wiley.
3. Ahmed and Zobaa, **Handbook of Renewable Energy Technology**, World Scientific.
4. Godfrey Boyle, **Renewable Energy: Power for a Sustainable Future**, Oxford University Press.
5. Ministry of New and Renewable Energy (MNRE), Government of India Reports and Publications.

Ramdeobaba University, Nagpur

Department of Mechanical Engineering

Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering

Session: 2026-27

Course Code	**Course Title**					**Category**
26ESPSE04TH0505-3	**Additive manufacturing Semester- V**					PCC
Contact Hours per Week				**CA**	**ESE**	**Credits**
L	**P**	**S**	Credits			
3	2	2	4	50 +50	50	3

Prerequisite: Engineering Graphics

Manufacturing Processes, Basics of Materials Science, CAD (Geometric Modeling), Basic Computer Programming (desirable)

Course Objectives: The objective of the course is to prepare the students

1. To develop understanding of additive manufacturing processes, materials, and design principles.
2. To enable students to apply AM tools for prototyping, product development, and industrial applications.

Course Outcomes: After completing this course, students will be able to:

CO1: Explain fundamentals, classifications, and principles of AM processes

CO2: Apply CAD tools for AM design and file preparation (STL, slicing)

CO3: Analyze process parameters and material behavior in AM

CO4: Evaluate AM vs conventional manufacturing for industrial applications

CO5: Design and fabricate components using AM machines and validate performance

Unit 1: Introduction to Additive Manufacturing

Definition, history, evolution, Classification: VAT photopolymerization, powder bed fusion, extrusion

Comparison with conventional manufacturing,

Unit 2: AM Process Technologies

FDM, SLA, SLS, DMLS, Binder Jetting, Machine components and working principles, Case studies (aerospace, biomedical)

Unit 3: Materials in AM

Polymers, metals, ceramics, composites, Material properties and selection, Defects and microstructure

Unit 4: Design for Additive Manufacturing (DfAM)

STL conversion, slicing, Topology optimization, Support structures, Software workflow

Unit 5: Applications & Future Trends

Industrial applications, Reverse engineering using EinScan 3D Scanner, Sustainability and Industry 4.0 integration, AI in AM

TEXT BOOKS:

1. Gibson, Rosen, Stucker – Additive Manufacturing Technologies
2. Ian Gibson – 3D Printing and AM Principles
3. Chua & Leong – Rapid Prototyping
4. Andreas Gebhardt – Understanding AM

REFERENCE BOOKS:

1. Liou – Rapid Prototyping and Engineering Applications
2. Hopkinson – Rapid Manufacturing ASTM Standards on AM

Course Code	Course Title				Category
26ES03TH0505-4	**Work System Design**				PSE 1
Contact Hours per Week			**CA**	**FE**	**Credits**
L	P	**S**			
3	0	1	50	50	03

Prerequisite: Nil

Course Objectives:

To develop the ability to design, analyze, and optimize work systems, plant layouts, and production processes using industrial engineering tools, while integrating lean principles, automation, and modern Industry 4.0 practices.

Course Outcomes:

Upon successful completion of the course, students will be able to:
CO1 — Apply work study techniques, method study tools, and work measurement methods to improve productivity in manufacturing systems.
CO2 — Analyze different plant layouts, flow patterns, and production systems to determine their suitability for specific industrial scenarios
CO3 — Analyse productivity factors, time standards, and system performance using appropriate industrial engineering metrics and digital tools.
CO4 — Evaluate work system designs and plant layouts by incorporating lean manufacturing principles and automation concepts.
CO5 — Evaluate assembly line balancing, task allocation, and integrated work systems to improve efficiency in modern manufacturing environments.

UNIT I: Work System Design and Productivity	**08 Hrs.**

Concept of work systems in manufacturing, productivity, factors affecting productivity, measures to improve productivity. Total time of job, management techniques to reduce work content and ineffective time. work study fundamentals, Digital productivity tracking and smart manufacturing metrics used in Industry 4.0 environments.

UNIT II: Method Study and Work Analysis	**07 Hrs.**

Systematic analysis and improvement of work methods using tools such as process charts, flow diagrams, and activity charts, micro-motion study, principles of motion

economy, and man-machine interaction analysis. The use of simulation tools, video-based analysis.
UNIT III: Work Measurement and Time Standards **7 Hrs.**
Techniques for measuring work and establishing time standards, including stopwatch time study, work sampling, and predetermined motion time systems (PMTS) such as MTM and MOST. performance rating, allowances, and standard time calculation.
UNIT IV: Plant Layout **8 Hrs.**
Plant layout: definition, objectives and types—product, process, fixed position, cellular, layouts with common flow patterns. Production systems: job, batch, line, and continuous production with characteristics, advantages, disadvantages, and selection assumptions. Basic features of modern manufacturing including automation, lean systems, and digital integration.
UNIT V: Integrated Work Systems, Lean and Automation **8 Hrs.**
Integration and optimization of complete work systems using modern industrial engineering approaches, Assembly line balancing: cycle time, task sequencing, workstation allocation, efficiency, and simple numerical problems. lean manufacturing, automation, smart factories, IoT-enabled systems, and human-robot collaboration.
Textbooks 1. Introduction to Work Study by ILO (International Labour Organization) 2.Industrial Engineering and Production Management by Martand Telsang 3. Ralph M. Barnes, *Motion and Time Study:* Design and Measurement of Work, Wiley.
Reference Books 1. Benjamin W. Niebel & Andris Freivalds, *Methods, Standards, and Work Design*, McGraw-Hill. 2. Maynard's Industrial Engineering Handbook, McGraw-Hill.

Course Code	**Course Title**					**Category**
26ESPSE04TH0505-5	**Fundamentals of Robotics**					**PSE**
Contact Hours per Week				**CA**	**ESE**	**Credits**
L		**P**	**Total**			
03		00	**03**	50	50	03
Prerequisite:						

Course Objectives:

1. To introduce the fundamental concepts of robot anatomy, configurations, and workspace.
2. To familiarize students with the working principles of various sensors and actuators used in robotics.
3. To provide an overview of robot control, programming methods, and their role in modern industry.

Course Outcomes: On successful completion of the module students will be able to:

CO1 Explain basic concepts, structure, robot configurations, and classification of robots.
CO2 Explain the working principles of robotic sensors and select suitable sensors for robotic applications.
CO3 Analyze robot drive and actuation systems.
CO4 Develop basic robot programs and control strategies.
CO5 Discuss robotic applications for industrial use.

UNIT I: INTRODUCTION	**07 Hrs.**

Definitions, history of robotics, benefit of robot, need of robot, laws of robotics, robot anatomy, types of robot, coordinate system, work envelope, robot specifications, robot parts and their functions, wrist and orientation.

UNIT II: SENSORS IN ROBOTICS	**08 Hrs.**

Definition of sensors, requirement of sensors, characteristics of sensors, classifications of sensors, **Internal Sensors**: Position sensors (Potentiometers, Encoders, LVDT), Velocity sensors (Tachometer, Hall effect sensor), acceleration sensors, **External Sensors:** Tactile (Touch sensors and force sensors), Proximity (Inductive, capacitive, ultrasonic), Range Sensors (LiDAR and IR sensors).

UNIT III: ROBOT ACTUATION AND DRIVE SYSTEMS	**08 Hrs.**

Definition, factors considered for selecting drive system, actuators, types of actuators: **Electric Drives:** Stepper motors, DC Servo motors, and BLDC motors; selection criteria for torque and speed. **Fluid Power:** Principles of Pneumatic and Hydraulic actuators; applications in industries. Comparison of pneumatic, hydraulic electrical drives. **Transmission Systems:** Gear transmission, Belt drives, Rollers, chains, Links, Linearto-Rotary motion conversion, Rotary-to-Linear motion conversion, Rack and Pinion drives, Lead screws, Ball Bearings.

UNIT IV: ROBOT CONTROL AND PROGRAMMING	**07 Hrs.**

Open-loop vs. Closed-loop systems; basic concepts of PID control for joint stability, Point-to-Point (PTP) vs. Continuous Path (CP) motion, methods for robot programming**:** Lead-through, textual, and Off-line programming defining a program, Method of defining position in space, Motion interpolation, Basic programming commands in workcell control (wait, signal and delay commands), Branching, Robot programming languages, Structure of robot language, VAL programming.

UNIT V: APPLICATIONS OF INDUSTRIAL ROBOT	**06 Hrs.**

Manufacturing applications of robot: Material handling, Machine loading / unloading, Spray painting,
Welding, Machining, Assembly, pick and place, Inspection. **Non manufacturing robotic applications:** Hazardous environment, Medical, Mining, Space, Defence, Security, Domestic, Entertainment, Agriculture, Distribution and others; Future of robotics. **Case Study for Robotic Applications** including Robot Selection considerations for a typical industrial application.

TEXT BOOKS:

1. S.K. Saha, *Introduction to Robotics*, McGraw Hill Education.
2. R.K. Mittal & I.J. Nagrath, *Robotics and Control*, Tata McGraw Hill.

REFERENCE BOOKS:

1. John J. Craig, *Introduction to Robotics: Mechanics and Control*, Pearson Education.
2. Saeed B. Niku, *Introduction to Robotics: Analysis, Control, Applications*, Wiley.
3. Mikell P. Groover, *Industrial Robotics: Technology, Programming, and Applications*, McGraw Hill.

Battery Technology and Energy Storage Systems (PSE)

26ESPSE04TH0606-2

Contact Hours per Week

L	P	S	CA	FE	Credits
3	0	2	50	50	3

Prerequisites

Students should possess:

1. Basic knowledge of Engineering Chemistry and Applied Physics.
2. Fundamental understanding of Electrical and Electronic Engineering concepts.
3. Basic knowledge of Renewable Energy Systems and Energy Conversion.
4. Understanding of Engineering Mathematics and data analysis fundamentals.

Course Objectives

The objective of this course is:

1. To introduce the principles, characteristics, and applications of modern battery technologies.
2. To understand electrochemical energy storage mechanisms and battery management systems.
3. To study various energy storage technologies used in renewable energy and electric vehicle applications.
4. To analyze battery performance, safety, reliability, and lifecycle management.
5. To develop competency in selecting and designing energy storage systems for engineering applications.

Course Outcomes

On successful completion of the course, the students will be able to:

CO1: Explain the fundamentals of electrochemical energy storage and various battery technologies.
CO2: Analyze the construction, working principles, and performance characteristics of modern batteries.
CO3: Evaluate battery management systems and charging technologies for electric vehicle and grid applications.
CO4: Assess alternative energy storage technologies and their suitability for different engineering applications.
CO5: Analyze battery degradation, safety, lifecycle, and sustainability aspects.
CO6: Design and evaluate energy storage systems for renewable energy and electric mobility applications using modern tools.

UNIT I: Fundamentals of Battery Technology 7 Hours

Introduction to energy storage systems.
Need for energy storage.
Electrochemical principles.
Cell, battery, and battery pack.
Battery terminology and performance parameters.

Voltage, capacity, energy density, power density, efficiency.
Battery classifications and applications.
Role of batteries in renewable energy and electric vehicles.

UNIT II: Battery Technologies 8 Hours

Lead-acid batteries.
Nickel-Cadmium batteries.
Nickel-Metal Hydride batteries.
Lithium-ion batteries.
Lithium Polymer batteries.
Solid-state batteries.
Sodium-ion batteries.
Construction, operation, advantages, limitations, and applications.
Comparison of battery technologies.

UNIT III: Battery Management Systems (BMS) and Charging Technologies 8 Hours

Battery monitoring systems.
State of Charge (SOC).
State of Health (SOH).
Cell balancing techniques.
Battery thermal management systems.
Battery protection systems.
Charging methods and charging standards.
Fast charging technologies.
Wireless charging.
Battery pack design considerations.

UNIT IV: Energy Storage Technologies 7 Hours

Supercapacitors.
Flywheel energy storage systems.
Compressed Air Energy Storage (CAES).
Pumped Hydro Energy Storage (PHES).
Hydrogen storage systems.
Fuel cells.
Hybrid energy storage systems.
Applications in renewable energy integration and smart grids.

UNIT V: Battery Safety, Sustainability and Applications 8 Hours

Battery degradation mechanisms.
Failure modes and safety considerations.
Thermal runaway.
Battery recycling technologies.
Environmental impacts.
Second-life applications.
Battery economics and lifecycle costing.
Energy storage for renewable energy systems.
Energy storage in electric vehicles and smart grids.
Future trends in battery technology.

Textbooks

1. A. Jossen and W. Weydanz, **Modern Battery Engineering: A Comprehensive Introduction**, Springer.
2. Huggins R. A., **Energy Storage: Fundamentals, Materials and Applications**, Springer.

3. Jiuchun Jiang and Caiping Zhang, **Fundamentals and Applications of Lithium-Ion Batteries in Electric Drive Vehicles**, Wiley.

References

1. Korthauer R., **Handbook of Battery Energy Storage Systems**, Springer.
2. Diouf B. and Pode R., **Potential of Lithium-Ion Batteries in Renewable Energy Systems**, Renewable Energy Journal.
3. Garche J., **Electrochemical Power Sources: Fundamentals, Systems and Applications**, Elsevier.
4. Linden D., **Handbook of Batteries**, McGraw Hill.
5. Ministry of New and Renewable Energy (MNRE) Publications and Reports.

Course Code	Course Title				Category
26ESPSE04TH0606-3	**Geometric Dimensioning and Tolerances**				PSE
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	0	2	50	50	3

Prerequisite: Basics of Manufacturing processes and production concepts

The objective of the course is:

- Understand GD&T principles and their application in design and manufacturing.
- Interpret technical drawings and identify tolerancing requirements, apply form, orientation and position tolerances.

Course Outcomes: At the end of this course students will be able to

CO1. Define and apply GD&T as per ASME Y14.5 standard.
CO2. Interpret and annotate drawings using correct GD&T symbols.
CO3. Use GD&T for defining form, orientation, location, and runout tolerances.
CO4. Explain the role of datums and material condition modifiers
CO5. Evaluate manufacturability and inspect ability using GD&T

Unit - I

Introduction to Micromachining: Macro, micro and nano machining: Principle of micro-machining, Historical background, Classification of micromachining and nano finishing processes, Requirements of micro-machining systems, Nanotechnology.

Unit - II

Mechanical Advanced Micromachining and Nano-finishing Processes: Introduction of basic elements and mechanism of material removal for processes as Abrasive Jet Micromachining, Ultrasonic Micromachining, Abrasive Water Jet Machining, Abrasive Flow nano finishing.

Unit - III

Thermoelectric Advanced Micromachining Processes: Electric Discharge Micromachining, Electric Discharge Grinding, Wire Electric Discharge Micromachining, Laser Beam Micromachining, Electron Beam Micromachining, Ion Beam Machining.

Unit - IV

Electrochemical and Chemical Micromachining Processes: Electrochemical Micromachining, Electrochemical Micro Grinding, Electro stream Micro milling and drilling, Electrochemical Micro deburring.

Unit – V

Micro Metrology: Scanning Electron Microscopy, Optical Microscopy, Atomic Force Microscope, Molecular Measuring Machine, Transmission Electron Microscope, Micro-CMM, Recent trends in micromachining and applications.

TEXT BOOKS:

1. Jain V. K. , Introduction to Micromachining, Narosa Publishers, New Delhi (2014)
2. Ghosh, A. and Mullick, S., Manufacturing Science, New Age International (2001).
3. Pandey, P.C. and Shan H.S., Modern Machining Processes, McGraw Hill (2004).

REFERENCE BOOKS:

1 CAD/CAM: M. Groover& E. Zimmers, Pearson Education, Delhi
2 Industrial Engg. & Production Management: Martand Telsang, S. Chand Publications, Delhi
3 Computer Control of Manufacturing Systems: Yoram Koren, Mcgraw Hill, Delhi

Course Code	**Course Title**				**Category**
26ESPSE04TH0606-4	**Facilities Planning and Design**				**Regular**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	**00**	**02**	**50**	**50**	**03**

Prerequisite:

Course Objectives:
To equip students with knowledge and techniques for effective utilization of plant space, machines, manpower, material flow, and other resources for improving productivity , Resource Utilization, Layout Optimization and operational efficiency.

Course Outcomes: On successful completion of the module, students will be able to:
CO1: Explain the fundamentals, scope, importance, principles, and objectives of facilities planning and design for manufacturing, service, and modern industrial systems.
CO2: Analyze facility location factors and evaluate process, product, cellular, fixed-position, and hybrid layouts using qualitative and quantitative approaches.
CO3: Apply layout planning and optimization techniques for effective utilization of space, equipment, manpower, material flow, energy, and other organizational resources.
CO4: Select and integrate suitable material handling systems, storage systems, automation-based flow systems, and warehouse practices to improve productivity, safety, and operational efficiency.
CO5: Apply CAD, simulation tools, lean principles, ergonomics, safety, maintenance, sustainability, and Industry 4.0 concepts in facilities planning and design.

UNIT I: Introduction to Facilities Planning	**06 Hrs.**

Meaning, scope, objectives and importance of facilities planning in manufacturing and service industries. Principles and key elements of facilities planning, including plant location, layout, material handling, storage, space utilization, equipment arrangement, safety and ergonomics. Role of facilities planning in improving productivity, cost reduction, smooth workflow and organizational efficiency. Overview of systematic facilities planning, industrial applications, case studies, emerging trends and challenges in facilities planning.

UNIT II: Facility Location Analysis	**06 Hrs.**

Meaning, importance and objectives of facility location analysis. Factors affecting facility location decisions such as raw material availability, market proximity, labour, transportation, land cost, utilities, infrastructure, government policies, environmental and safety requirements. Qualitative and quantitative factors in location selection. Methods of location analysis: factor rating method, load-distance method, centre of gravity method, break-even analysis and transportation model. Selection of location for manufacturing plants, warehouses and service facilities. Case studies and emerging trends in facility location planning.

UNIT III: Layout Planning and Design	**09 Hrs.**

Meaning, objectives and principles of layout planning and design. Types of layouts: process layout, product layout, fixed-position layout, cellular layout and hybrid layout. Factors influencing layout design such as material flow, space utilization, equipment arrangement, manpower movement, safety, flexibility and future expansion. Techniques of layout planning including flow analysis, activity relationship chart, space requirement analysis, block layout and systematic layout planning. Evaluation of layouts based on material handling cost, productivity, workflow efficiency, safety and ergonomics. Use of CAD and simulation tools in layout planning and industrial case studies.

UNIT IV: Material Handling Systems	**09 Hrs.**

Meaning, objectives, importance and principles of material handling systems. Classification of material handling equipment such as conveyors, cranes, hoists, trucks, forklifts, AGVs, robots and automated storage/retrieval systems. Selection of material handling equipment based on material type, quantity, movement distance, flow pattern, safety, cost and flexibility. Analysis of material flow, unit load concept, storage systems, warehouse handling and movement of materials in manufacturing systems. Role of material handling in reducing cost, improving productivity, minimizing delays, ensuring safety and supporting efficient facility layout. Emerging trends such as automation, robotics, smart warehousing and Industry 4.0 in

UNIT V: Facility Design and Maintenance	**09 Hrs.**

Meaning, objectives and importance of facility design and maintenance in manufacturing and service organizations. Factors influencing facility design such as capacity, flexibility, space utilization, workflow, safety, ergonomics, utilities, environmental requirements and future expansion. Principles of effective facility design for improving productivity, operational efficiency and employee safety. Maintenance concepts: preventive maintenance, predictive maintenance, breakdown maintenance and condition-based maintenance. Role of maintenance in reducing downtime, improving equipment reliability and extending facility life. Energy management, waste reduction, green facility design, sustainability and environmental considerations in facility operations. Case studies and modern trends in facility design and maintenance.

TEXT BOOKS:

1. S. C. Sharma and T. R. Banga, *Industrial Engineering and Management*, Second Edition, Khanna Publishing House, 2025. ISBN: 978-93-55380-09-8. (Khanna Publishing House)
2. R. Panneerselvam, *Production and Operations Management*, Third Edition, PHI Learning Pvt. Ltd., New Delhi. ISBN: 978-8120345553. (PHI Learning)
3. G. K. Agarwal, *Plant Layout and Material Handling*, Second Edition, Jain Brothers, New Delhi, 2020. ISBN: 978-8186321782. (Jain Book Depot)

REFERENCE BOOKS:

1. Tompkins, J. A., White, J. A., Bozer, Y. A., and Tanchoco, J. M. A., *Facilities Planning*, Wiley, 2010.
2. Slack, N., Brandon-Jones, A., and Johnston, R., *Operations Management*, Pearson Education Limited, 2016.
3. Rosenthal, E., *Warehouse and Distribution Facility Planning*, CRC Press, 2016.
4. Chikwendu, D. O., *Introduction to Material Handling Systems*, CRC Press, 2015.
5. Kumar, S., *Facility Layout and Location: An Analytical Approach*, CRC Press, 2018.
6. Hillier, F. S., and Lieberman, G. J., *Introduction to Operations Research*, McGraw-Hill Education, 2019.

Course Code	**Course Title**				**Category**
26ESPSE04TH0606-5	**Artificial Intelligence**				Professional Core
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**Total**			
03	0	03	50	50	**03**

Course Objectives:

After completing this course, students will be able to:

Basic problem-solving techniques, intelligent agents, and AI applications through introductory learning approaches in AI.

Course Outcomes (CO)

After successful completion of the course, students will be able to:

CO1: Explain fundamental concepts of artificial intelligence and intelligent agents
CO2: Apply search algorithms to solve simple AI problems
CO3: Analyze adversarial and constraint satisfaction problems
CO4: Evaluate knowledge representation and uncertainty techniques
CO5: Explain basic concepts of modern AI including neural networks, Transformers, LLMs, and RAG

UNIT I: Introduction to Artificial Intelligence and Agents	**07 Hrs.**
Introduction to AI, history and applications, task domains, Basics of problem solving, problem characteristics, problem representation (toy and real-world problems); Intelligent agents, rational agents, task environment, performance measures, simple real-world examples of AI systems	
UNIT II: Uninformed Search Techniques	**7 Hrs.**
State space representation, Breadth First Search, Depth First Search, Uniform Cost Search, Depth Limited Search, Iterative Deepening DFS, Bidirectional Search, simple problem-solving examples	
UNIT III: Informed Search and Learning Basics	**7 Hrs.**
Heuristic based search, Greedy Best First Search, A* Search; Local search algorithms: Hill-climbing, Genetic Algorithms (conceptual); Introduction to learning in AI, basic idea of machine learning	
UNIT IV: Adversarial Search and Constraint Satisfaction	**7 Hrs.**

Two-player games, Min-Max algorithm, Alpha-Beta pruning (conceptual); Constraint Satisfaction Problems, backtracking search, constraint propagation, real-world examples (puzzles, scheduling)

UNIT V: Knowledge Representation and Introduction to Modern AI	**7 Hrs.**

Propositional logic, First Order Logic (basic syntax and semantics), inference mechanisms (forward and backward chaining); Introduction to probability and Bayes' theorem, Naïve Bayes (concept only);

TEXT BOOKS:

1. Artificial Intelligence: A Modern Approach — Stuart Russell, Peter Norvig, Pearson, 4th Edition
2. Artificial Intelligence — Elaine Rich, Kevin Knight, McGraw-Hill Education

REFERENCE BOOKS:

1. Machine Learning — Tom M. Mitchell, McGraw-Hill Education
2. Pattern Recognition and Machine Learning — Christopher M. Bishop, Springer
3. Deep Learning — Ian Goodfellow, Yoshua Bengio, Aaron Courville, MIT Press

Course Code	**Course Title**					**Category**
26ESPSE04TH0702-3	**Industrial Internet of Things (IIoT)**					PCC
Contact Hours per Week				**CA**	**ESE**	**Credits**
L	**P**	**S**	Credits			
3	0	2	3	50	50	3

Prerequisite: Engineering Mathematics, Basics of Electrical Engineering, Python Programming,

Course Objectives: The objective of the course is to prepare the students

1. To understand architecture and components of Industrial IoT systems.
2. To develop skills for data acquisition, analysis, and smart manufacturing applications.

Course Outcomes: After completing this course, students will be able to:

CO1: Explain IIoT architecture, sensors, and communication protocols
CO2: Develop IoT-based data acquisition systems using hardware/software tools
CO3: Analyze industrial data using cloud platforms and basic analytics
CO4: Implement IIoT solutions with machine learning for predictive maintenance
CO5: Design smart manufacturing/monitoring systems for real-world applications

Unit I: The Industrial Edge (Hardware & Sensing)

IIoT Fundamentals: Definitions, evolution from M2M, and the 4-layer architecture (Perception, Network, Middleware, Application).
The Physical Layer: Sensors: Theory and application of Temperature, Pressure, Vibration, Flow, Proximity, and LVDT, Actuators: Solenoids, Servo drives, VFDs, and Pneumatic systems. Signal conditioning (Amplifiers, Filters), ADC/DAC, and Data Acquisition Systems (DAQ).

Unit II: Embedded Intelligence & Local Connectivity

Controller Platforms: Microprocessors vs. Microcontrollers; hands-on overview of Arduino, ESP32, and Raspberry Pi.
Edge Programming: GPIO programming with Python (Digital I/O, PWM) on Raspberry Pi.
Wired Bus Protocols: Principles and wiring for UART, SPI, and I2C.
Industrial Networking: Modbus (RTU/TCP): Architecture and frame structure, OPC-UA: The modern standard for industrial interoperability.

Unit III: IIoT Communication & Cloud Integration

Wireless Stack: Comparison of Wi-Fi, Zigbee, LoRaWAN, and NB-IoT (Range vs. Power vs. Reliability).

Messaging Protocols: MQTT: Deep dive into Broker, Pub/Sub model, and QoS levels, Web Protocols: HTTP/REST for IoT.

Cloud Ecosystems: Integration with AWS IoT Core, Microsoft Azure IoT Hub, and ThingSpeak, Middleware: Hands-on with HiveMQ or Mosquitto brokers.

Unit IV: Data Engineering & Industrial Analytics

Data Management: Time-series databases (InfluxDB), Data logging, and visualization with Grafana.

Preprocessing Pipeline: Using Python (Pandas, NumPy) for cleaning, normalization, and feature extraction.

Machine Learning for IIoT: Supervised/Unsupervised: Regression and Classification basics via scikit-learn, Anomaly Detection: Isolation Forest and One-class SVM for sensor health.

Predictive Maintenance: Random Forest for Remaining Useful Life (RUL) prediction.

Unit V: Industry 4.0 Applications & Security

The Digital Twin: Concepts, architecture, and applications in manufacturing.

Smart Factory Operations: Condition monitoring and OEE (Overall Equipment Effectiveness) calculation, IIoT in Energy Management: Smart metering and demand response.

Capstone Case Study: End-to-end pipeline (Sensor - MQTT - Cloud - ML Model - Alert).

TEXT BOOKS:

1. Raj Kamal – Internet of Things
2. Programming the Internet of Things Andy King, O'Reilly Media 2021
3. Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow
4. Raspberry Pi and Python for IIoT Applications Warren Gay, Apress 2019

REFERENCE BOOKS:

1. Aurélien Géron, O'Reilly Media 3rd Ed., 2022
2. Industrial Internet of Things, Sabina Jeschke, Christian Brecher et al., Springer 2017

Course Code	Course Title				Category
26ES03TH0702-4	**Lean Manufacturing and Value Engineering**				PSE 3
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**T**	**D/P**			
03	00	00	50	50	03

Prerequisite: Nil

Course Objectives:

To develop understanding of lean manufacturing principles and value engineering techniques for improving productivity, quality, and cost efficiency.

Course Outcomes:

On successful completion of the course, students will be able to:

CO1: Apply lean manufacturing principles to identify waste and improve efficiency in production systems.

CO2:Analyse and implement lean tools such as VSM, JIT, Kanban, and TPM in automated manufacturing environments.

CO3: Evaluate production performance using OEE, maintenance strategies, and data-driven approaches in smart systems.
CO4: Apply value engineering techniques for function analysis and cost optimization in product and process design.
CO5: Integrate lean manufacturing and value engineering concepts to enhance productivity, sustainability, and competitiveness in modern industries.

UNIT I: Lean Manufacturing Fundamentals and Smart Production Systems	**07 Hrs.**

Lean philosophy and evolution, Toyota Production System principles, lean vs traditional manufacturing, identification of waste (Muda, Mura, Muri), value-added and non-value-added activities, takt time, cycle time, lead time analysis, pull vs push systems, continuous flow manufacturing, introduction to Industry 4.0, cyber-physical production systems, smart factories, digital manufacturing concepts, role of automation and robotics in lean environments.

UNIT II: Lean Tools, Techniques and Process Optimization	**08 Hrs.**

5S methodology and workplace organization, Kaizen and continuous improvement strategies, Just-In-Time (JIT) production, Kanban systems, visual management systems, standardized work procedures, line balancing techniques, cellular manufacturing, group technology, bottleneck identification, value stream mapping (current and future state), process flow analysis in automated systems, integration with flexible manufacturing systems (FMS) and robotic cells.

UNIT III: Advanced Lean Systems and Automation Integration	**08 Hrs.**

Total Productive Maintenance (TPM), Overall Equipment Effectiveness (OEE), breakdown analysis and maintenance strategies, SMED (Single Minute Exchange of Dies), setup time reduction, poka-yoke and error-proofing systems, reliability engineering in automated production, sensor-based monitoring, IoT-enabled predictive maintenance, real-time data acquisition, , AI-based process optimization, lean implementation in CNC and robotic systems.

UNIT IV: Value Engineering	**07 Hrs.**

Concept of value, cost-worth analysis, function definition and classification, FAST (Function Analysis System Technique), value engineering job plan phases, creativity and idea generation techniques, evaluation and selection methods, product cost reduction strategies, design for manufacturability (DFM), design for assembly (DFA), application in automated product design.

UNIT V: Lean–Value Engineering Integration	**07 Hrs.**

Integration of lean and value engineering, value stream cost analysis, elimination of non-value functions, lean product development, concurrent engineering, cost reduction in automated production systems, lean supply chain and inventory reduction, sustainability and green manufacturing, application in automotive and electronics industries, role of AI and data analytics in lean systems, challenges in implementation, lean culture and continuous improvement practices.

TEXT BOOKS:

1. Ohno, T., *Toyota Production System: Beyond Large-Scale Production*, Productivity Press.
3.Miles, L.D., *Techniques of Value Analysis and Engineering*, McGraw Hill.

REFERENCE BOOKS:

1.Womack, J.P. and Jones, D.T., *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*, Free Press
2.Mudge, A.E., *Value Engineering: A Systematic Approach*, McGraw Hill.

Machine Learning (PSE)

Course Code: 26ESPSE04TH0702-5
Contact Hours per Week

L	P	S	CA	FE	Credits
3	0	2	3	50	50

Prerequisites
Students should possess:
1. Basic knowledge of Engineering Mathematics, Statistics, and Probability.
2. Fundamentals of Python Programming.
3. Basic understanding of Artificial Intelligence concepts.
4. Knowledge of Data Analytics and Data Handling Techniques.

Course Objectives
The objective of this course is:
1. To introduce the concepts, techniques, and applications of Machine Learning.
2. To develop skills in data pre-processing, feature engineering, and model building.
3. To understand supervised and unsupervised learning algorithms.
4. To apply machine learning techniques for engineering and industrial applications.
5. To develop competency in evaluating and deploying machine learning models.

Course Outcomes
On successful completion of the course, the students will be able to:
CO1: Explain fundamental concepts, workflow, and applications of machine learning.
CO2: Perform data pre-processing, feature selection, and exploratory data analysis for machine learning applications.
CO3: Develop and evaluate supervised learning models for prediction and classification problems.
CO4: Apply unsupervised learning techniques for clustering, dimensionality reduction, and pattern discovery.
CO5: Analyze machine learning model performance and optimize model parameters.
CO6: Design machine learning solutions for manufacturing, robotics, automation, and engineering systems.

UNIT I: Introduction to Machine Learning **7 Hours**
Introduction to Artificial Intelligence, Data Science, and Machine Learning.
Machine Learning workflow.
Types of Machine Learning.
Applications in Mechanical Engineering, Robotics, Manufacturing, and Industry 4.0.
Data acquisition and preparation.
Machine Learning lifecycle.
Introduction to Python libraries: NumPy, Pandas, Matplotlib, Scikit-Learn.

UNIT II: Data Pre-processing and Feature Engineering **8 Hours**
Data collection and cleaning.
Handling missing values.
Data transformation and normalization.
Feature extraction and selection.
Data visualization techniques.
Exploratory Data Analysis (EDA).
Training, validation, and testing datasets.
Cross-validation techniques.

UNIT III: Supervised Learning Algorithms **8 Hours**
Regression Techniques:
- Linear Regression
- Multiple Linear Regression
- Polynomial Regression

Classification Techniques:
- Logistic Regression
- K-Nearest Neighbors (KNN)
- Decision Trees
- Random Forest

Applications in predictive maintenance, quality prediction, and demand forecasting.

UNIT IV: Unsupervised Learning Algorithms **7 Hours**
Clustering Techniques:
- K-Means Clustering
- Hierarchical Clustering

Dimensionality Reduction:
- Principal Component Analysis (PCA)

Association Rule Mining.
Pattern recognition.
Industrial applications of clustering and anomaly detection.

UNIT V: Model Evaluation and Engineering Applications **8 Hours**
Model performance metrics.
Confusion Matrix.
Accuracy, Precision, Recall, F1 Score.
ROC Curve and AUC.
Hyperparameter tuning.
Overfitting and underfitting.
Introduction to Deep Learning and Neural Networks.
Applications in:
- Predictive Maintenance
- Smart Manufacturing
- Industrial Automation
- Robotics
- Supply Chain Analytics
- Energy Systems

Textbooks
1. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow, O'Reilly Media.
2. Tom M. Mitchell, Machine Learning, McGraw Hill.
3. Ethem Alpaydin, Introduction to Machine Learning, MIT Press.

References
1. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer.
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press.
3. Andreas Müller and Sarah Guido, Introduction to Machine Learning with Python, O'Reilly Media.
4. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press.
5. Scikit-Learn Official Documentation and Python Machine Learning Resources.

Course Code	Course Title	Category
26ESPSE04TH0703-2	**Electric Vehicle Technology**	**ESC**

Ramdeobaba University, Nagpur

Department of Mechanical Engineering

Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering

Session: 2026-27

Contact Hours per Week			CA	FE	Credits
L	P	S			
3	0	-	50	50	03

Prerequisite: Students should possess basic knowledge of Engineering Mechanics, Thermodynamics, and Electrical Engineering fundamentals. Familiarity with IC engines, basic electronics, and energy systems will be helpful.

Course Objectives:

After completing this course, students will be able to:

1. To give comprehensive insight into the electric vehicle domain, including EV architecture, e-motors, energy storage systems and their control.
2. To expose students to the process of motor sizing, selection of batteries, range and charging time calculations for EV applications.

Course Outcomes:

After successful completion of the course, students will be able to:

CO1: Enlist the benefits of EVs and differentiate between various EV architectures

CO2: Analyse the tractive force requirement and chose type of e motor to be used for given application

CO3: Compare various battery technologies and Identify application specific battery and energy management system

CO4: Outline modes and types of chargers and emphasize the importance of vehicle to grid communication.

CO5: Demonstrate the safety requirements as per various standards for EVs and subsystems.

UNIT I: Introduction to Electric Vehicles	8 Hours
History and evolution of electric vehicles, global and Indian EV scenario, current trends and future scope. Advantages of EVs over conventional vehicles, challenges in EV adoption. EV efficiency and performance parameters. Basic architecture of electric vehicles: power source, electric motor and auxiliary systems. Comparison between ICE vehicles and EVs.	
UNIT II: EV Drives, Motors and Control	8 Hours
Tractive effort and vehicle dynamics, calculation of tractive force and power requirement. Motor sizing and selection criteria for EV applications. Types of motors used in EVs: DC motor, Induction motor, construction, working principles, advantages and limitations.	
UNIT III: **Energy Storage Systems**	8 Hours
Overview of energy storage systems in EVs. Lead-acid batteries: construction, working, advantages and limitations. Lithium-ion batteries: types, characteristics, advantages over conventional batteries. Comparison of different battery chemistries. Battery parameters and terminology (SOC, SOH, depth of discharge, C-rate). Introduction to converters and inverters used in EVs. Battery Management System (BMS): functions, architecture and importance.	
UNIT IV: **EV Charging Systems and Infrastructure**	8 Hours
Types of EV charging (AC/DC), slow, fast and rapid charging. Charging modes and charger classifications. Communication between vehicle and grid (G2V and V2G concepts). Challenges in developing EV charging networks.	
Unit V: **Safety, Testing, Certification and Emerging Trends**	8 Hours

Safety aspects in EVs: electrical, thermal and functional safety. Standards for EV components (battery, motor, power electronics). Testing procedures for electric vehicles Policy framework and business opportunities in EV sector. Advanced topics: Fuel cells, types and working principles. Hydrogen as an alternative fuel and Fuel Cell Electric Vehicles (FCEVs).

TEXT BOOKS:

1. Iqbal Hussain, "Electric & Hybrid Vehicles – Design Fundamentals", Second Edition, CRC Press, 2011.
2. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.

REFERENCE BOOKS:

1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals", Third Edition, CRC Press, 2018.

Course Code	Course Title				Category
26ESPSE04TH0703-3	**Sustainability and Green Manufacturing**				**PSE**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	**0**	**-**	**50**	**50**	**03**

Prerequisite: Basic knowledge of Manufacturing Processes, Materials Science, and Environmental Studies.

Course Objectives:

After completing this course, students will be able to:

1. Study the concepts, principles, and approaches of sustainable and green manufacturing.
2. Understand modern techniques and strategies used to improve sustainability and productivity in manufacturing processes.

Course Outcomes:

After successful completion of the course, students will be able to:

CO1: Understand concept of green manufacturing and approaches for sustainable Manufacturing.
CO2: Understand green manufacturing techniques and Process performance with Industrial case studies.
CO3: Understand application of productivity measures and techniques for machinability improvement.
CO4: Understand modern approaches for Sustainable Manufacturing
CO5: Understand and implement strategies for waste reduction, energy efficiency, and sustainable resource management in manufacturing systems

UNIT I: **Introduction to sustainable manufacturing.**	**8 Hours**

Introduction of green factory, Sustainability and its relevance. Metrics for green manufacturing. Modern approaches for Sustainable Manufacturing, Toxic substances in industry and need of Renewable sources.

UNIT II: importance of green manufacturing	**7 Hours**

Difficulties in machining. Importance of cutting fluids, Health hazard and environmental issues using coolants. Coolant selection criteria. Motivations behind the use of green machining. Study of Green manufacturing techniques and Process performance with Industrial and research based case studies.

UNIT III: Systems concept for productivity improvement	**7 Hours**
Application of productivity measures. Typical measures of affecting productivity. Machinability: Techniques for Machinability improvement. Various Instruments used for Green Machining.	
UNIT IV: Modern approaches for Sustainable Manufacturing	**7 Hours**
Efficiency of Manufacturing Processes. Energy Efficiency characterization of Manufacturing Processes. Energy Efficiency Practices in Manufacturing .	
Unit V: Green Manufacturing Techniques	**7 Hours**
Dry Machining, Near-Dry Machining (Minimum Quantity Lubrication - MQL), Edible Oil-Based Cutting Fluids, Cryogenic Machining – principles, working, advantages, limitations, and comparison with conventional machining.	
TEXT BOOKS: 1. Green Manufacturing: Fundamentals and Applications by David A. Dornfeld, Springer US publisher 2013. 2. Green Manufacturing Process and System by Davim J. Paulo, Springer Verlag Berlin Heidelberg publication 2013	
REFERENCE BOOKS: 1. Efficiency of Manufacturing Process- Energy and Ecological Perspectives by Li Wen. Springer International Publisher – 2015	

Course Code	**Course Title**				**Category**
26ESPSE04TH0703-4	**Engineering Economy and Cost Control**				PSE
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	P	**S**			
03	00	01	50	50	03

Prerequisite: Nil

Course Objectives:

1. To develop understanding of engineering economic principles and financial concepts for effective decision-making in mechanical engineering applications.
2. To enable evaluation of projects, cost structures, and financial performance using basic economic and accounting tools.
3. To apply cost control and management techniques for improving efficiency and profitability in manufacturing systems.

Course Outcomes:

On successful completion of the course, students will be able to:

CO1: Apply fundamental concepts of engineering economics and finance in industrial decision-making.

CO2: Evaluate and compare engineering projects using economic analysis techniques such as worth methods and rate of return.

CO3: Analyse depreciation and financial statements for assessing performance of mechanical systems and enterprises.

CO4: Apply cost accounting methods and costing techniques in manufacturing and production environments.

CO5: Use management accounting tools such as break-even analysis, budgeting, and cost control techniques for improving efficiency and profitability.

UNIT I: Finance Function and Engineering Economy	**07 Hrs.**

Definition and scope of finance function, role of finance in engineering enterprises, sources of finance, ownership and borrowed capital, types of companies and company formation, introduction to capital and stock markets, basics of engineering economy, time value of money, simple and compound interest, cash flow diagrams.

UNIT II: Economic Analysis and Project Evaluation	**07 Hrs.**

Present, future and annual worth methods, nominal and effective interest rates, gradient series, minimum attractive rate of return (MARR), payback period, rate of return methods, comparison and selection of alternatives, replacement decisions, economic decision-making in engineering projects.

UNIT III: Depreciation and Financial Statement Analysis	**08 Hrs.**

Concept and need of depreciation, methods of depreciation (straight line, declining balance), impact on machine and equipment costs, basic elements of accounting, preparation of profit and loss account and balance sheet, interpretation of financial statements, ratio analysis for industrial decision-making.

UNIT IV: Cost Accounting and Costing Methods	**08 Hrs.**

Introduction to cost accounting, elements of cost (material, labor, overhead), costing systems, job costing and batch costing, process costing (normal and abnormal losses), cost estimation, cost control techniques in manufacturing industries.

UNIT V: Management Accounting and Cost Control Techniques	**07 Hrs.**

Management accounting concepts, marginal costing, break-even analysis, cost-volume-profit (CVP) analysis, budgeting and budgetary control, fixed and flexible budgets, standard costing and variance analysis, cost-based decision making like make or buy decisions, cost control and cost reduction strategies.

TEXT BOOKS:

1.Riggs, J.L., Bedworth, D.B., and Randhawa, S.U., *Engineering Economics*, McGraw Hill Education.

2. Prasanna Chandra, *Fundamentals of Financial Management*, McGraw Hill Education.

REFERENCE BOOKS:

1.Blank, L. and Tarquin, A., *Engineering Economy*, McGraw Hill Education.

2.Park, C.S., *Contemporary Engineering Economics*, Pearson Education.

3.Khan, M.Y. and Jain, P.K., *Financial Management*, McGraw Hill Education.

Course Code	Course Title				Category
26ESPSE04TH0703-5	**Mobile Robotics**				**PSE**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	00	01	50	50	03

Prerequisite: Fundamentals of Robotics**,** Field & Service Robot

Course Objectives:

1. To introduce the fundamentals of mobile and micro robotics and their unique design challenges.
2. To develop understanding of locomotion, actuation, sensing, and control at micro scale.
3. To explain power and communication constraints in micro-robotic systems.
4. To expose students to real-world applications and emerging trends in micro robotics.

Course Outcomes: On successful completion of the module students will be able to:

CO1.Explain concepts, challenges, and applications of mobile and micro robots.
CO2.Analyze locomotion and actuation mechanisms for micro-robot systems.
CO3.Apply sensing and control techniques in micro-robotic environments.
CO4. Evaluate power and communication strategies for efficient micro-robot operation.
CO5. Design a basic micro-robotic solution for a given application.

UNIT I: INTRODUCTION TO MOBILE AND MICRO ROBOTS	**09 Hrs.**

Overview of micro robotic applications, size constraints, locomotion mechanisms at micro scale, challenges in miniaturization. Comparison between macro and micro robots in terms of design, mobility and application domains. Regulatory challenges in micro-robot deployments.

UNIT II: LOCOMOTION AND ACTUATION	**09 Hrs.**

Locomotion mechanisms: wheeled, legged, snake-like, and bio-inspired systems. Micro-scale actuation: piezoelectric, electrostatic, magnetic, and soft actuators. Hybrid mobility systems and compliant mechanisms. Performance comparison and selection of actuation techniques.

UNIT III: SENSING AND CONTROL	**9 Hrs.**

MEMS-based sensors, minimal sensing strategies, and sensor integration. On-board vs external control, embedded controllers for micro robots. Sensor noise, filtering techniques, and basic control strategies. Wireless sensing and decentralized control concepts.

UNIT IV: POWER AND COMMUNICATION	**9 Hrs.**

Energy sources: micro batteries, energy harvesting, and wireless charging. Power density and energy management strategies. Communication techniques: RF, optical, and magnetic. Design considerations for low-latency and reliable communication in micro systems.

UNIT V: APPLICATIONS AND CASE STUDIES	**9 Hrs.**

Applications in medical, surveillance, precision agriculture, and hazardous environments. Bio-inspired and swarm micro-robot systems. Case studies of recent research developments and performance evaluation.

TEXT BOOKS:

[1] Bradley Nelson, 'Micro and Nano Robotics', Springer.
[2] Gregory Dudek, Michael Jenkin, 'Computational Principles of Mobile Robotics', Cambridge.

REFERENCE BOOKS:

[1] Paolo Dario, 'Microrobotics for Biomedical Applications', Springer.
[2] Recent IEEE Transactions on Robotics and Mechatronics papers.

MOOC COURSES:

1. Coursera: Nanorobotics – https://www.coursera.org/learn/nanorobotics
2. edX: Introduction to Soft Robotics – https://www.edx.org/course/soft-robotics

Honors Scheme (Design and Computational Engineering)

Detailed Syllabus

Session: 2026-27

Hydraulics and Pneumatics

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26ES04HT0301	Hydraulics and Pneumatics	Honors	03-00-02	50	50	03

Prerequisite: Fluid Mechanics, Basic Mechanical Engineering.

Course Objectives:

The objectives of this course are: To enable students to understand the principles of fluid power transmission and control, and to design, analyze and maintain hydraulic and pneumatic systems used in industrial automation and mechanical engineering applications.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain basic principles, properties of hydraulic fluids, and components of hydraulic power systems.

CO2: Analyze and design hydraulic circuits using pumps, valves, actuators and accumulators.

CO3: Describe pneumatic system components and analyze pneumatic circuits for industrial applications.

CO4: Apply electro-hydraulic and electro-pneumatic control techniques for automation.

CO5: Evaluate maintenance, troubleshooting, and safety aspects of fluid power systems.

UNIT I: INTRODUCTION TO FLUID POWER AND HYDRAULIC SYSTEMS

Definition, scope and advantages of fluid power, comparison of hydraulic and pneumatic systems, hydraulic fluids: properties, types and selection criteria, basics of fluid power transmission, Pascal's law, pressure-force-area relationship.

UNIT II: HYDRAULIC PUMPS, ACTUATORS AND VALVES

Classification and working of hydraulic pumps: gear, vane and piston pumps, pump performance characteristics, hydraulic cylinders and motors, pressure control valves, directional control valves, flow control valves, hydraulic accumulators.

UNIT III: HYDRAULIC CIRCUIT DESIGN

Design and analysis of hydraulic circuits: regenerative circuit, sequencing circuit, synchronizing circuit, meter-in and meter-out circuits, accumulator circuits, industrial applications of hydraulic circuits.

UNIT IV: PNEUMATIC SYSTEMS

Properties of air, production, distribution and conditioning of compressed air, pneumatic actuators, pneumatic valves, design of basic pneumatic circuits, cascade method for circuit design, applications in automation.

UNIT V: ELECTRO-HYDRAULIC / PNEUMATIC CONTROL AND MAINTENANCE

Solenoid valves, electrical control circuits, relay logic, introduction to PLC based control of hydraulic and pneumatic systems, maintenance, troubleshooting and safety practices in fluid power systems.

TEXT BOOKS:

1. S. R. Majumdar, Oil Hydraulic Systems: Principles and Maintenance, McGraw Hill Education, 2001.
2. S. R. Majumdar, Pneumatic Systems: Principles and Maintenance, 2nd Edition, McGraw Hill Education, 2019.
3. Anthony Esposito, Fluid Power with Applications, 7th Edition, Pearson Education, 2013.

REFERENCE BOOKS:

1. Andrew Parr, Hydraulics and Pneumatics: A Technician's and Engineer's Guide, 3rd Edition, Butterworth-Heinemann, 2011.
2. John Pippenger and Tyler Hicks, Industrial Hydraulics, 3rd Edition, McGraw Hill, 1979.
3. K. Krishna Reddy, Fluid Power Systems, University Press, 2016.

Mechanical Vibrations

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26ES04HT0401	Mechanical Vibrations	Honors	03-00-02	50	50	03

Prerequisite: Engineering Mechanics, Theory of Machines, Engineering Mathematics (Differential Equations).

Course Objectives:

The objectives of this course are: To enable students to understand the fundamental concepts of mechanical vibrations and to apply analytical techniques for the analysis, measurement and control of vibrations in mechanical systems.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain basic concepts and terminology associated with mechanical vibrations.

CO2: Analyze free vibration of undamped and damped single degree of freedom systems.

CO3: Analyze forced vibration response of single degree of freedom systems subjected to harmonic excitation.

CO4: Analyze vibration of two and multi-degree of freedom systems.

CO5: Apply vibration measurement and control techniques including balancing and vibration isolation.

UNIT I: FUNDAMENTALS OF VIBRATION

Definitions and terminology, causes and effects of vibration, classification of vibration: free, forced, damped, undamped, linear and nonlinear, degrees of freedom, simple harmonic motion, vibration analysis procedure.

UNIT II: FREE VIBRATION OF SINGLE DEGREE OF FREEDOM SYSTEMS

Undamped free vibration: spring-mass systems, energy method, Rayleigh's method, damped free vibration: viscous damping, logarithmic decrement, critical, over-damped and under-damped systems, torsional vibration of single rotor systems.

UNIT III: FORCED VIBRATION OF SINGLE DEGREE OF FREEDOM SYSTEMS

Forced vibration with harmonic excitation, magnification factor, resonance, vibration isolation and transmissibility, support motion, vibration measuring instruments: seismometer and accelerometer.

UNIT IV: TWO AND MULTI-DEGREE OF FREEDOM SYSTEMS

Free and forced vibration of two degree of freedom systems, principal modes and natural frequencies, coordinate coupling, vibration absorbers, introduction to multi-degree of freedom systems, matrix method, influence coefficients.

UNIT V: BALANCING AND VIBRATION CONTROL

Balancing of rotating masses: single and multiple planes, balancing of reciprocating masses, whirling of shafts, critical speed, introduction to vibration control techniques, condition monitoring, basics of experimental modal analysis.

TEXT BOOKS:

1. Singiresu S. Rao, Mechanical Vibrations, 6th Edition, Pearson Education, 2018.
2. V. P. Singh, Mechanical Vibrations, 3rd Edition, Dhanpat Rai & Co., 2016.
3. G. K. Grover, Mechanical Vibrations, 8th Edition, New Chand & Bros, 2009.

REFERENCE BOOKS:

1. William T. Thomson and Marie Dillon Dahleh, Theory of Vibration with Applications, 5th Edition, Pearson Education, 2018.
2. J. S. Rao and K. Gupta, Introductory Course on Theory and Practice of Mechanical Vibrations, 2nd Edition, New Age International, 1999.
3. Leonard Meirovitch, Elements of Vibration Analysis, 2nd Edition, McGraw Hill, 1986.

Stress Analysis

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26ES04HT0501	Stress Analysis	Honors	04-00-02	50	50	04

Prerequisite: Strength of Materials, Engineering Mathematics.

Course Objectives:

The objectives of this course are: To enable students to apply advanced analytical and numerical techniques for stress and strain analysis of machine components and structures, ensuring safe and optimal design under complex loading conditions.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain fundamental concepts of stress, strain, and theories of failure applied to machine design.

CO2: Analyze stresses in curved beams, thick cylinders, and rotating discs.

CO3: Apply energy methods for analysis of deflection and stresses in structural and machine members.

CO4: Analyze stress concentration and apply fundamentals of theory of elasticity to two-dimensional problems.

CO5: Apply finite element method fundamentals for stress analysis of machine components.

UNIT I: FUNDAMENTALS OF STRESS ANALYSIS

Review of stress and strain, principal stresses and strains, Mohr's circle, three-dimensional stress analysis, theories of elastic failure: maximum principal stress, maximum shear stress and distortion energy theory, and their applications in design.

UNIT II: BENDING OF CURVED BEAMS AND THICK CYLINDERS

Stresses in curved beams: Winkler-Bach theory, applications to crane hooks, chain links and press frames, thick cylinders: Lame's equations, compound cylinders, stresses due to internal and external pressure, basics of autofrettage.

UNIT III: ENERGY METHODS

Strain energy in axial, bending, torsional and shear loading, Castigliano's theorem, unit load method, applications to determine deflection of beams, trusses and curved members, basics of impact and dynamic loading.

UNIT IV: STRESS CONCENTRATION AND THEORY OF ELASTICITY

Stress concentration factors, methods of reducing stress concentration, fatigue and stress concentration, introduction to theory of elasticity, plane stress and plane strain problems, Airy's stress function, basic two-dimensional elasticity problems.

UNIT V: INTRODUCTION TO FINITE ELEMENT METHOD FOR STRESS ANALYSIS

Basic concept of finite element method, discretization, shape functions, stiffness matrix formulation for bar and beam elements, application of FEM software for stress analysis of simple machine components, interpretation of results.

TEXT BOOKS:

1. R. G. Budynas, Advanced Strength and Applied Stress Analysis, 2nd Edition, McGraw Hill, 1999.
2. L. S. Srinath, Advanced Mechanics of Solids, 3rd Edition, McGraw Hill Education, 2009.
3. R. G. Boresi and K. P. Chong, Advanced Mechanics of Materials, 6th Edition, Wiley, 2002.

REFERENCE BOOKS:

1. S. P. Timoshenko and J. N. Goodier, Theory of Elasticity, 3rd Edition, McGraw Hill, 1970.
2. Robert D. Cook, David S. Malkus and Michael E. Plesha, Concepts and Applications of Finite Element Analysis, 4th Edition, Wiley, 2001.
3. Ansel C. Ugural, Stresses in Plates and Shells, 2nd Edition, McGraw Hill, 1999.

Introduction to CFD

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26ES04HT0601	Introduction to CFD	Honors	04-00-02	50	50	04

Prerequisite: Fluid Mechanics, Heat Transfer, Numerical Methods.

Course Objectives:

The objectives of this course are: To enable students to understand the governing equations of fluid flow, discretization techniques, and to apply computational fluid dynamics tools for the analysis of engineering flow and heat transfer problems.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain governing equations of fluid flow and classification of partial differential equations.

CO2: Apply finite difference and finite volume discretization techniques for CFD analysis.

CO3: Analyze numerical solution methods for diffusion and convection-diffusion problems.

CO4: Apply pressure-velocity coupling algorithms for solution of Navier-Stokes equations.

CO5: Apply CFD software for grid generation, simulation and post-processing of simple fluid flow problems.

UNIT I: GOVERNING EQUATIONS OF FLUID FLOW

Introduction to CFD and its applications in mechanical engineering, continuity, momentum and energy equations, classification of partial differential equations: elliptic, parabolic and hyperbolic, initial and boundary conditions.

UNIT II: DISCRETIZATION TECHNIQUES

Finite difference method: forward, backward and central difference schemes, finite volume method: concept and formulation, grid generation: structured and unstructured grids, consistency, stability and convergence of numerical schemes.

UNIT III: NUMERICAL SOLUTION OF DIFFUSION AND CONVECTION-DIFFUSION PROBLEMS

One-dimensional steady state diffusion, unsteady state diffusion: explicit, implicit and Crank-Nicolson schemes, convection-diffusion problems, upwind scheme, hybrid scheme, power-law scheme, concept of false diffusion.

UNIT IV: SOLUTION ALGORITHMS FOR NAVIER-STOKES EQUATIONS

Pressure-velocity coupling, staggered grid, SIMPLE algorithm, SIMPLER and SIMPLEC algorithms, boundary conditions for pressure and velocity, solution of algebraic equations using TDMA method, introduction to turbulence modeling.

UNIT V: APPLICATION OF CFD SOFTWARE

Overview of commercial CFD software, pre-processing: geometry creation and mesh generation, solver setup: boundary conditions and solution methods, post-processing: visualization and interpretation of results, case studies in heat transfer and fluid flow.

TEXT BOOKS:

1. H. K. Versteeg and W. Malalasekera, An Introduction to Computational Fluid Dynamics: The Finite Volume

Method, 2nd Edition, Pearson Education, 2007.

2. Suhas V. Patankar, Numerical Heat Transfer and Fluid Flow, 1st Edition, CRC Press, 1980.

3. John D. Anderson, Computational Fluid Dynamics: The Basics with Applications, McGraw Hill, 1995.

REFERENCE BOOKS:

1. T. J. Chung, Computational Fluid Dynamics, 2nd Edition, Cambridge University Press, 2010.

2. Klaus A. Hoffmann and Steve T. Chiang, Computational Fluid Dynamics, Volume I, 4th Edition, Engineering Education System, 2000.

3. C. A. J. Fletcher, Computational Techniques for Fluid Dynamics, Volumes 1 and 2, 2nd Edition, Springer, 1991.

Project

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26ES04HP0701	Project	Honors	00-08-00	50	50	04

Prerequisite: All core and honors courses of the Design and Computational Engineering stream (Hydraulics and Pneumatics, Mechanical Vibrations, Stress Analysis, Introduction to CFD).

Course Objectives:

The objectives of this course are: To enable students to apply the knowledge and skills acquired in design and computational engineering courses to identify, formulate, design, analyze and execute an engineering project independently or in a team, and to develop the professional and technical competencies required for engineering practice.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Identify and formulate a real-life engineering problem related to design and computational engineering.

CO2: Conduct literature review and survey relevant to the identified problem.

CO3: Apply design and computational tools and techniques to develop a solution for the identified problem.

CO4: Analyze, validate and interpret the results obtained from design, simulation or experimentation.

CO5: Prepare technical documentation and present the project work effectively through report writing and oral presentation.

Guidelines:

The project may be design-based, simulation-based (using CAD/CAE/CFD/FEA tools), or experimental in nature, related to any one of the Honors courses (Hydraulics and Pneumatics, Mechanical Vibrations, Stress Analysis, Introduction to CFD) or an integration thereof. Students shall work individually or in small groups under the guidance of a faculty mentor. Continuous evaluation shall be based on periodic reviews assessing problem formulation, methodology and progress, while the end semester evaluation shall comprise the project report and a viva-voce / final presentation.

Minor Scheme offered by ME: Mechanical Systems and Technology

Detailed Syllabus

Session: 2026-27

Computer Aided Design

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26ES04MT0301	Computer Aided Design	Minor	03-00-02	50	50	03

Prerequisite: Engineering Graphics, Machine Drawing, Basics of Computer Programming.

Course Objectives:

The objectives of this course are: To enable students to understand the fundamentals of computer aided design, geometric modeling techniques, and to apply CAD software tools for the design, modeling and drafting of mechanical components.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain fundamentals, benefits and applications of Computer Aided Design in product development.

CO2: Apply transformation techniques and geometric modeling for representation of mechanical components.

CO3: Develop curves, surfaces and solid models using CAD techniques.

CO4: Apply assembly modeling and design procedures for standard mechanical components.

CO5: Utilize CAD software for drafting, dimensioning and generation of engineering drawings.

UNIT I: INTRODUCTION TO CAD

Definition, scope and benefits of CAD, product design and development process, CAD hardware: input/output devices, graphics standards, overview of CAD software, 2D and 3D transformations: translation, scaling, rotation, reflection, concatenation of transformations.

UNIT II: GEOMETRIC MODELING - CURVES

Mathematical representation of curves: parametric and non-parametric forms, Hermite cubic splines, Bezier curves, B-spline curves, properties and applications of curves in CAD.

UNIT III: GEOMETRIC MODELING - SURFACES AND SOLIDS

Surface representation: Bezier and B-spline surfaces, surface of revolution, ruled surfaces, solid modeling techniques: wireframe, surface and solid models, constructive solid geometry (CSG), boundary representation (B-Rep), feature-based modeling.

UNIT IV: ASSEMBLY MODELING AND DESIGN

Assembly modeling concepts, mating conditions and constraints, bottom-up and top-down assembly approaches, design of standard machine elements using CAD: fasteners, keys and shafts, interference checking, exploded views.

UNIT V: CAD APPLICATIONS AND DRAFTING

Generation of orthographic views, dimensioning and tolerancing (basics of GD&T), detailing and drafting

standards, introduction to parametric and feature-based CAD software, case studies of mechanical component design, basic introduction to CAD data exchange formats (IGES, STEP).

TEXT BOOKS:

1. Ibrahim Zeid and R. Sivasubramanian, CAD/CAM: Theory and Practice, 2nd Edition, McGraw Hill Education, 2009.

2. P. N. Rao, CAD/CAM: Principles and Applications, 3rd Edition, McGraw Hill Education, 2010.

3. David F. Rogers and J. Alan Adams, Mathematical Elements for Computer Graphics, 2nd Edition, McGraw Hill, 1990.

REFERENCE BOOKS:

1. Mikell P. Groover and Emory W. Zimmers, CAD/CAM: Computer-Aided Design and Manufacturing, Pearson Education, 2003.

2. Kunwoo Lee, Principles of CAD/CAM/CAE Systems, Pearson Education, 1999.

3. Chris McMahon and Jimmie Browne, CADCAM: Principles, Practice and Manufacturing Management, 2nd Edition, Pearson Education, 1998.

Digital Manufacturing

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26ES04MT0401	Digital Manufacturing	Minor	03-00-02	50	50	03

Prerequisite: Manufacturing Processes, Computer Aided Design.

Course Objectives:

The objectives of this course are: To enable students to understand the concepts of digital manufacturing and Industry 4.0 technologies, and to apply digital tools for the design, planning, simulation and control of manufacturing systems.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain fundamentals and scope of digital manufacturing and Industry 4.0 in mechanical engineering.

CO2: Apply Computer Aided Process Planning techniques for manufacturing.

CO3: Analyze CNC programming and computer aided manufacturing techniques for manufacturing processes.

CO4: Apply concepts of rapid prototyping and additive manufacturing for product development.

CO5: Describe digital twin, IoT and smart manufacturing systems for Industry 4.0 applications.

UNIT I: INTRODUCTION TO DIGITAL MANUFACTURING

Definition and scope of digital manufacturing, evolution of manufacturing systems, Industry 4.0: concepts, pillars and enabling technologies, role of digital manufacturing in product lifecycle management (PLM), introduction to cyber-physical systems.

UNIT II: COMPUTER AIDED PROCESS PLANNING

Introduction to process planning, variant and generative approaches to CAPP, group technology and part family

classification, computer aided process planning systems, benefits and applications.

UNIT III: CNC TECHNOLOGY AND COMPUTER AIDED MANUFACTURING

CNC machine tools: construction and classification, CNC part programming: manual and computer aided, canned cycles, introduction to CAM software, tool path generation and post-processing, basics of direct numerical control (DNC) systems.

UNIT IV: RAPID PROTOTYPING AND ADDITIVE MANUFACTURING

Introduction to rapid prototyping and additive manufacturing, classification of AM processes: SLA, SLS, FDM and DMLS, process parameters and materials, applications of additive manufacturing in mechanical engineering, basics of reverse engineering.

UNIT V: SMART MANUFACTURING AND DIGITAL TWIN

Introduction to Internet of Things (IoT) in manufacturing, digital twin: concept and applications, cloud manufacturing, basics of big data and analytics in manufacturing, cyber security basics for manufacturing systems, case studies of smart factories.

TEXT BOOKS:

1. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 4th Edition, Pearson Education, 2015.
2. Amit Bandyopadhyay and Susmita Bose, Additive Manufacturing, 2nd Edition, CRC Press, 2019.
3. P. Radhakrishnan, S. Subramanyan and V. Raju, CAD/CAM/CIM, 3rd Edition, New Age International, 2008.

REFERENCE BOOKS:

1. Ian Gibson, David Rosen and Brent Stucker, Additive Manufacturing Technologies, 2nd Edition, Springer, 2015.
2. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016.
3. Yoram Koren, The Global Manufacturing Revolution, Wiley, 2010.

Renewable Energy Resources

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26ES04MT0501	Renewable Energy Resources	Minor	04-00-02	50	50	04

Prerequisite: Thermodynamics, Basic Electrical Engineering.

Course Objectives:

The objectives of this course are: To enable students to understand the principles, technologies and applications of various renewable energy resources for sustainable energy generation and utilization.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the need, scope and potential of renewable energy resources for sustainable development.

CO2: Analyze solar energy collection, conversion technologies and applications.

CO3: Analyze wind energy conversion systems and their design considerations.

CO4: Describe biomass, biogas and geothermal energy conversion technologies.

CO5: Evaluate energy storage systems, hybrid energy systems and economics of renewable energy.

UNIT I: INTRODUCTION TO RENEWABLE ENERGY

Conventional and non-conventional energy sources, need and importance of renewable energy, global and Indian energy scenario, environmental aspects of energy utilization, overview of solar, wind, biomass, geothermal, tidal and ocean energy resources.

UNIT II: SOLAR ENERGY

Solar radiation: measurement and estimation, solar thermal collectors: flat plate and concentrating collectors, solar water heating, solar drying, solar cooking, solar photovoltaic systems: principle, types of solar cells, PV module characteristics, applications of solar PV systems.

UNIT III: WIND ENERGY

Wind energy potential and characteristics, wind turbine types: horizontal and vertical axis, components of wind energy conversion system, power in wind, Betz limit, site selection criteria, wind farm layout, basics of grid integration.

UNIT IV: BIOMASS, BIOGAS AND GEOTHERMAL ENERGY

Biomass resources and conversion technologies: combustion, pyrolysis and gasification, biogas generation: types of biogas plants, factors affecting biogas generation, geothermal energy: resources and types, geothermal power generation systems and applications.

UNIT V: ENERGY STORAGE AND ECONOMICS OF RENEWABLE ENERGY

Energy storage technologies: battery storage, pumped hydro storage, thermal energy storage, hybrid renewable energy systems, hydrogen energy and fuel cells: basic concept, economics of renewable energy systems, government policies and incentives.

TEXT BOOKS:

1. G. D. Rai, Non-Conventional Energy Sources, 5th Edition, Khanna Publishers, 2011.
2. B. H. Khan, Non-Conventional Energy Resources, 3rd Edition, McGraw Hill Education, 2017.
3. Godfrey Boyle, Renewable Energy: Power for a Sustainable Future, 3rd Edition, Oxford University Press, 2012.

REFERENCE BOOKS:

1. C. S. Solanki, Renewable Energy Technologies: A Practical Guide for Beginners, 2nd Edition, PHI Learning, 2015.
2. D. Yogi Goswami, Frank Kreith and Jan F. Kreider, Principles of Solar Engineering, 3rd Edition, CRC Press, 2015.
3. John Twidell and Tony Weir, Renewable Energy Resources, 3rd Edition, Routledge, 2015.

Operation Research

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26ES04MT0601	Operation Research	Minor	04-00-02	50	50	04

Prerequisite: Engineering Mathematics, Probability and Statistics, Production Planning and Control basics.

Course Objectives:

The objectives of this course are: To enable students to formulate and solve engineering and industrial decision-making problems using Operations Research techniques for optimal resource utilization, cost minimization, productivity improvement, and effective planning and control.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Describe the basic concepts, scope, methodology, and applications of Operations Research in mechanical engineering systems.

CO2: Formulate and solve linear programming problems using graphical and simplex methods.

CO3: Apply transportation and assignment models for optimal allocation of resources.

CO4: Analyze sequencing, inventory, and replacement problems for manufacturing and service systems.

CO5: Apply project scheduling, queuing theory, and decision theory techniques for industrial decision-making.

UNIT I: INTRODUCTION TO OPERATIONS RESEARCH AND LINEAR PROGRAMMING

Definition, meaning, scope, and applications of Operations Research, characteristics and limitations of Operations Research, phases of Operations Research study, role of Operations Research in mechanical engineering, production planning, maintenance, inventory, project management, and industrial systems. Linear Programming Problem: formulation of LPP, assumptions of LPP, mathematical model of LPP, objective function and constraints, graphical method for two-variable problems, special cases: multiple solution, infeasible solution, and unbounded solution.

UNIT II: SIMPLEX METHOD AND DUALITY

Standard form of Linear Programming Problem, slack variables, surplus variables and artificial variables, simplex method for maximization and minimization problems, Big-M method, Two-Phase method, concept of duality, primal-dual relationship, economic interpretation of dual variables, basic concept of sensitivity analysis.

UNIT III: TRANSPORTATION AND ASSIGNMENT PROBLEMS

Transportation Problem: mathematical formulation, balanced and unbalanced transportation problems, initial basic feasible solution using North-West Corner Method, Least Cost Method, and Vogel's Approximation Method, optimality test using MODI method, degeneracy in transportation problem. Assignment Problem: mathematical formulation, Hungarian method, minimization and maximization assignment problems, unbalanced assignment problem, travelling salesman problem: basic concept and applications.

UNIT IV: SEQUENCING, INVENTORY AND REPLACEMENT MODELS

Sequencing Problems: processing of jobs through machines, n jobs through 2 machines, n jobs through 3 machines, 2 jobs through m machines, applications in production scheduling and manufacturing systems. Inventory Control: meaning and importance of inventory, types of inventory, inventory costs, Economic Order Quantity model, EOQ model with and without shortages, reorder level, safety stock, ABC analysis. Replacement Models: replacement of items that deteriorate with time, replacement of items that fail suddenly, individual and group replacement policies, applications in maintenance management.

UNIT V: PROJECT SCHEDULING, QUEUING THEORY AND DECISION THEORY

Project Scheduling: network construction, Critical Path Method, Program Evaluation and Review Technique, earliest start time, latest start time, earliest finish time, latest finish time, float and slack, project crashing: basic concept. Queuing Theory: introduction to waiting line models, elements of queuing system, arrival rate, service rate, single-server queuing model, applications in maintenance, service centres, machine repair, and production systems. Decision Theory: decision-making under certainty, risk, and uncertainty, maximax, maximin, minimax regret, Laplace and Hurwicz criteria, Expected Monetary Value, decision tree: basic concept.

TEXT BOOKS:

1. P. K. Gupta and D. S. Hira, Operations Research, 7th Edition, S. Chand Publishing, New Delhi, 2022.

2. Hamdy A. Taha, Operations Research: An Introduction, 11th Edition, Pearson Education, 2023.

3. Kanti Swarup, P. K. Gupta and Man Mohan, Operations Research, 20th Revised Edition, Sultan Chand & Sons, New Delhi, 2022.

REFERENCE BOOKS:

1. J. K. Sharma, Operations Research: Theory and Applications, 6th Edition, Macmillan Publishers India, 2020.

2. R. Panneerselvam, Operations Research, 3rd Edition, PHI Learning Pvt. Ltd., New Delhi, 2023.

3. N. D. Vohra and Hitesh Arora, Quantitative Techniques in Management, 6th Edition, McGraw Hill Education, 2021.

4. S. D. Sharma, Operations Research, Revised Edition, Kedar Nath Ram Nath & Co., Meerut.

5. Frederick S. Hillier and Gerald J. Lieberman, Introduction to Operations Research, 11th Edition, McGraw Hill Education, 2021.

6. A. Ravindran, Don T. Phillips and James J. Solberg, Operations Research: Principles and Practice, 2nd Edition, John Wiley & Sons / Wiley India, 2007 Indian Reprint.

7. Wayne L. Winston, Operations Research: Applications and Algorithms, 3rd Revised Edition, Duxbury Press, Belmont, California, 1994.

8. V. K. Kapoor, Operations Research, Sultan Chand & Sons, New Delhi, 2014.

Project

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26ES04MP0701	Project	Minor	00-08-00	50	50	04

Prerequisite: All core and minor courses of the Mechanical Systems and Technology stream (Computer Aided Design, Digital Manufacturing, Renewable Energy Resources, Operation Research).

Course Objectives:

The objectives of this course are: To enable students to apply the knowledge and skills acquired in the Mechanical Systems and Technology courses to identify, formulate, design, analyze and execute an engineering project independently or in a team, and to develop the professional and technical competencies required for engineering practice.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Identify and formulate a real-life engineering problem related to mechanical systems and technology.

CO2: Conduct literature review and survey relevant to the identified problem.

CO3: Apply design, manufacturing or computational tools and techniques to develop a solution for the identified problem.

CO4: Analyze, validate and interpret the results obtained from design, simulation or experimentation.

CO5: Prepare technical documentation and present the project work effectively through report writing and oral

presentation.

Guidelines:

The project may be design-based (using CAD tools), manufacturing/process-based (digital manufacturing and CAM techniques), energy-system-based (renewable energy applications), or optimization-based (using Operations Research techniques), or an integration thereof. Students shall work individually or in small groups under the guidance of a faculty mentor. Continuous evaluation shall be based on periodic reviews assessing problem formulation, methodology and progress, while the end semester evaluation shall comprise the project report and a viva-voce / final presentation.

Minor Scheme available for Mechanical Engineering students offered by EE: e-Mobility (BEST)

Detailed Syllabus

Session: 2026-27

Foundation of EV (e-Mobility)

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE04MT0301	Foundation of EV (e-Mobility)	Minor	03-00-02	50	50	03

Prerequisite: Basic Electrical Engineering, Basics of Automobile Engineering.

Course Objectives:

The objectives of this course are: To enable students to understand the fundamentals of electric vehicle technology, architecture and components, and to develop foundational knowledge required for the design and development of e-mobility solutions.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamentals, history, and classification of electric and hybrid electric vehicles.

CO2: Describe EV architecture and configuration of various electric vehicle subsystems.

CO3: Analyze vehicle dynamics and performance characteristics of electric vehicles.

CO4: Describe energy storage systems and charging infrastructure used in electric vehicles.

CO5: Explain the regulatory, safety and standards framework applicable to electric vehicles in India.

UNIT I: INTRODUCTION TO ELECTRIC VEHICLES

History and evolution of electric vehicles, need for electrification of transportation, classification: BEV, HEV, PHEV, FCEV, comparison of conventional IC engine vehicles and electric vehicles, global and Indian EV market scenario, overview of government policies (FAME, PLI schemes).

UNIT II: EV ARCHITECTURE AND CONFIGURATION

Electric vehicle architecture: series, parallel and series-parallel hybrid configurations, layout of BEV subsystems: battery, motor, power electronics and transmission, EV powertrain components, energy flow in electric vehicles, concept of regenerative braking.

UNIT III: VEHICLE DYNAMICS AND PERFORMANCE

Basics of vehicle dynamics, tractive effort and resistance, vehicle performance characteristics: acceleration, gradability and maximum speed, energy consumption and range estimation, factors affecting EV range, overview of drive cycles.

UNIT IV: ENERGY STORAGE AND CHARGING INFRASTRUCTURE

Overview of energy storage technologies for EVs, battery types and characteristics (introductory), charging methods: AC and DC charging, charging standards and connectors, charging infrastructure planning, battery swapping stations, basic concept of wireless charging.

UNIT V: EV SAFETY, STANDARDS AND FUTURE TRENDS

Electrical safety in EVs, overview of functional safety standards, testing and certification requirements (AIS standards, ISO 26262 - overview), basics of thermal management, recycling and second-life applications of EV batteries, emerging trends in e-mobility.

TEXT BOOKS:

1. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, 3rd Edition, CRC Press, 2021.
2. James Larminie and John Lowry, Electric Vehicle Technology Explained, 2nd Edition, Wiley, 2012.
3. Mehrdad Ehsani, Yimin Gao, Stefano Longo and Kambiz Ebrahimi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, 3rd Edition, CRC Press, 2018.

REFERENCE BOOKS:

1. Sandeep Dhameja, Electric Vehicle Battery Systems, Newnes, 2001.
2. C. C. Chan and K. T. Chau, Modern Electric Vehicle Technology, Oxford University Press, 2001.
3. ARAI / AIS Standards on Electric Vehicles - relevant technical publications and bulletins.

Battery Pack Design and BMS

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE04MT0401	Battery Pack Design and BMS	Minor	03-00-02	50	50	03

Prerequisite: Foundation of EV (e-Mobility), Basic Electrical Engineering, Basics of Electrochemistry.

Course Objectives:

The objectives of this course are: To enable students to understand battery chemistry and characteristics, to design battery packs for electric vehicles, and to understand the architecture and functions of Battery Management Systems.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamentals of battery chemistry and characteristics of batteries used in EVs.

CO2: Design battery pack configuration considering cell arrangement, capacity and voltage requirements.

CO3: Analyze thermal management systems for battery packs.

CO4: Explain the functions and architecture of Battery Management Systems (BMS).

CO5: Apply state of charge and state of health estimation techniques for battery monitoring.

UNIT I: BATTERY FUNDAMENTALS

Basics of electrochemistry, battery terminology: capacity, voltage, energy density, power density and C-rate, types of batteries used in EVs: lead acid, NiMH, lithium-ion (LFP, NMC, NCA), comparison of battery chemistries, battery characteristics and specifications.

UNIT II: BATTERY PACK DESIGN

Cell to pack design process, series and parallel cell configuration, pack voltage and capacity calculation, mechanical design considerations, module and pack level design, basics of busbar and interconnect design, battery pack enclosure design considerations.

UNIT III: THERMAL MANAGEMENT SYSTEMS

Heat generation in batteries, thermal runaway: causes and prevention, air cooling, liquid cooling and phase change material based cooling systems, thermal management system design considerations, safety aspects in thermal management.

UNIT IV: BATTERY MANAGEMENT SYSTEM

Functions of BMS: monitoring, protection, balancing and communication, BMS architecture: centralized, distributed and modular, cell balancing techniques: passive and active balancing, overview of BMS communication protocols (CAN bus).

UNIT V: STATE ESTIMATION AND BATTERY TESTING

State of Charge (SOC) estimation methods, State of Health (SOH) estimation, battery degradation mechanisms, battery testing procedures and standards, battery pack safety testing, introduction to second-life applications of EV batteries.

TEXT BOOKS:

1. Sandeep Dhameja, Electric Vehicle Battery Systems, Newnes, 2001.
2. Gregory L. Plett, Battery Management Systems, Volume I: Battery Modeling, Artech House, 2015.
3. Davide Andrea, Battery Management Systems for Large Lithium-Ion Battery Packs, Artech House, 2010.

REFERENCE BOOKS:

1. Reiner Korthauer (Ed.), Lithium-Ion Batteries: Basics and Applications, Springer, 2018.
2. Christopher D. Rahn and Chao-Yang Wang, Battery Systems Engineering, Wiley, 2013.
3. Bruno Scrosati, Jurgen Garche and Werner Tillmetz (Eds.), Advances in Battery Technologies for Electric Vehicles, Woodhead Publishing, 2015.

EV Charger Development and Testing

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE04MT0501	EV Charger Development and Testing	Minor	04-00-02	50	50	04

Prerequisite: Basics of Power Electronics, Foundation of EV (e-Mobility).

Course Objectives:

The objectives of this course are: To enable students to understand electric vehicle charging technologies, the design of chargers and associated power electronic converters, and testing methodologies for evaluating EV charging infrastructure.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the classification, standards, and topologies of electric vehicle charging systems.

CO2: Analyze power electronic converter topologies used in AC and DC EV chargers.

CO3: Design onboard and off-board charger circuits for electric vehicles.

CO4: Apply charging communication protocols and control strategies for EV chargers.

CO5: Perform testing, validation and safety compliance evaluation of EV chargers.

UNIT I: INTRODUCTION TO EV CHARGING SYSTEMS

Overview of EV charging methods: AC and DC charging, charging levels (Level 1, 2 and 3), onboard and off-board chargers, charging standards: IEC 61851, CCS, CHAdeMO, GB/T and Bharat AC001/DC001, overview of charging connector types.

UNIT II: POWER ELECTRONIC CONVERTERS FOR EV CHARGERS

AC-DC converter topologies: rectifiers and power factor correction circuits, DC-DC converter topologies: buck, boost, buck-boost and isolated converters, high frequency transformer based converters, converter selection for onboard and off-board chargers.

UNIT III: ONBOARD AND OFF-BOARD CHARGER DESIGN

Design considerations for onboard chargers: power rating, size and weight constraints, off-board DC fast charger design, thermal management of chargers, EMI/EMC considerations in charger design, charger efficiency and power quality aspects.

UNIT IV: CHARGING COMMUNICATION AND CONTROL

Communication protocols for EV charging: CAN, PLC and an overview of OCPP, control pilot signaling in AC charging, communication between vehicle and charger in DC fast charging, smart charging concepts, basic concept of vehicle-to-grid (V2G).

UNIT V: TESTING AND VALIDATION OF EV CHARGERS

Testing standards and procedures for EV chargers, electrical safety testing, performance testing: efficiency, power factor and harmonics, overview of environmental and EMI/EMC testing, certification requirements for chargers in India.

TEXT BOOKS:

1. Sheldon S. Williamson, Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer, 2013.

2. Chris Mi, M. Abul Masrur and David Wenzhong Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, 2nd Edition, Wiley, 2017.

3. Rajesh Kumar and Sanjeevikumar Padmanaban, Electric Vehicle Charging Infrastructure, CRC Press, 2022.

REFERENCE BOOKS:

1. IEC 61851, Electric Vehicle Conductive Charging System, relevant parts (standard document).

2. Bharat EV Charging Standards - AC001 and DC001, Ministry of Power, Government of India.

3. Muhammad H. Rashid, Power Electronics: Circuits, Devices and Applications, 4th Edition, Pearson Education, 2013.

Motor Design Drive Testing

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE04MT0601	Motor Design Drive Testing	Minor	04-00-02	50	50	04

Prerequisite: Basics of Electrical Machines, Basics of Power Electronics.

Course Objectives:

The objectives of this course are: To enable students to understand the design principles of electric motors used in EVs, motor drive systems, and testing procedures for evaluating motor and drive performance.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the classification and characteristics of electric motors used in EV traction applications.

CO2: Analyze the design principles of Permanent Magnet Synchronous Motors and Induction Motors for EV applications.

CO3: Analyze power electronic drive systems and control strategies for EV traction motors.

CO4: Evaluate motor performance parameters through simulation and analysis.

CO5: Perform testing and validation of electric motors and drive systems as per applicable standards.

UNIT I: TRACTION MOTORS FOR ELECTRIC VEHICLES

Requirements of traction motors, classification: DC motors, induction motors, permanent magnet synchronous motors and switched reluctance motors, comparison of motor technologies for EV applications, motor selection criteria.

UNIT II: MOTOR DESIGN PRINCIPLES

Basic design considerations of Permanent Magnet Synchronous Motor: magnetic circuit design, winding design and PM material selection, basics of Induction Motor design for EV traction, thermal design considerations, torque-speed characteristics.

UNIT III: MOTOR DRIVE SYSTEMS

Power electronic inverter topologies for motor drives, basics of field oriented control (FOC), overview of direct torque control (DTC), sensor and sensorless control techniques, regenerative braking control.

UNIT IV: SIMULATION AND PERFORMANCE ANALYSIS

Motor modeling and simulation using software tools, performance evaluation: torque-speed curve and efficiency map, losses in motor and drive, basics of thermal simulation, drive cycle based performance evaluation.

UNIT V: TESTING AND VALIDATION OF MOTOR AND DRIVE

Motor testing procedures: no-load and load testing, dynamometer testing, drive system testing, efficiency and thermal testing, overview of applicable IS/IEC standards for motor and drive testing, test bench setup and data acquisition.

TEXT BOOKS:

1. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, 3rd Edition, CRC Press, 2021.
2. R. Krishnan, Permanent Magnet Synchronous and Brushless DC Motor Drives, CRC Press, 2010.
3. Ali Emadi, Advanced Electric Drive Vehicles, CRC Press, 2014.

REFERENCE BOOKS:

1. Duane Hanselman, Brushless Permanent Magnet Motor Design, 2nd Edition, Magna Physics Publishing, 2006.
2. Bimal K. Bose, Modern Power Electronics and AC Drives, Pearson Education, 2002.
3. Chris Mi, M. Abul Masrur and David Wenzhong Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, 2nd Edition, Wiley, 2017.

Vehicle Testing

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE04MP0701	Vehicle Testing	Minor	00-08-00	50	50	04

Prerequisite: All core and minor courses of the e-Mobility stream (Foundation of EV, Battery Pack Design and BMS, EV Charger Development and Testing, Motor Design Drive Testing).

Course Objectives:

The objectives of this course are: To enable students to apply the knowledge and skills gained in e-mobility courses to conduct comprehensive testing and validation of electric vehicle systems and subsystems, and to develop practical competency in EV testing procedures.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Identify testing requirements and prepare test plans for electric vehicle systems and subsystems.

CO2: Conduct battery pack and BMS performance and safety testing.

CO3: Conduct motor and drive system testing using appropriate test equipment.

CO4: Conduct EV charger testing and validate compliance with applicable standards.

CO5: Analyze test data, prepare test reports and present vehicle testing outcomes.

Guidelines:

Vehicle Testing shall involve hands-on practical work on electric vehicle subsystems - battery pack, BMS, motor drive, and charging systems - covering test planning, execution, data acquisition and analysis. Students shall work individually or in small groups under the guidance of a faculty mentor / industry expert, following relevant testing standards and safety protocols. Continuous evaluation shall be based on periodic testing exercises and progress reviews, while the end semester evaluation shall comprise a comprehensive test report and viva-voce / demonstration of testing outcomes.

Minor Scheme available for Mechanical Engineering students offered by EE: Nuclear Engineering Systems

Detailed Syllabus

Session: 2026-27

Nuclear Fundamentals - I

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE04MT0301	Nuclear Fundamentals - I	Minor	03-00-02	50	50	03

Prerequisite: Engineering Physics, Basic Chemistry, Basic Mathematics.

Course Objectives:

The objectives of this course are: To enable students to understand the fundamental concepts of atomic and nuclear physics, radioactivity, and nuclear reactions relevant to nuclear engineering systems.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the basic atomic and nuclear structure, and properties of the nucleus.

CO2: Describe the phenomenon of radioactivity, decay laws and types of radioactive decay.

CO3: Explain nuclear reactions, cross-sections, and interaction of radiation with matter.

CO4: Describe the process of nuclear fission and fusion and the associated energy release.

CO5: Explain the basic principles of radiation detection and its biological effects.

UNIT I: ATOMIC AND NUCLEAR STRUCTURE

Atomic models, structure of the nucleus, nuclear binding energy, mass defect, nuclear stability, isotopes, isobars and isotones, basic concept of nuclear forces, overview of the semi-empirical mass formula.

UNIT II: RADIOACTIVITY

Radioactivity: alpha, beta and gamma decay, decay law, half-life, mean life, activity, radioactive equilibrium, natural and artificial radioactivity, radioactive series, units of radioactivity.

UNIT III: NUCLEAR REACTIONS AND CROSS SECTIONS

Types of nuclear reactions, Q-value of nuclear reactions, concept of cross-section, microscopic and macroscopic cross-sections, neutron interactions: scattering, absorption and fission, interaction of gamma rays and charged particles with matter.

UNIT IV: NUCLEAR FISSION AND FUSION

Fission process: mechanism, energy release and fission products, chain reaction, concept of criticality, fusion process: basic concept and conditions for fusion, comparison of fission and fusion energy, applications of nuclear fission and fusion.

UNIT V: RADIATION DETECTION AND BIOLOGICAL EFFECTS

Basic principles of radiation detection, overview of types of radiation detectors, biological effects of radiation, radiation dose and units, concept of radiation protection, introduction to the ALARA principle.

TEXT BOOKS:

1. Raymond L. Murray and Keith E. Holbert, Nuclear Energy: An Introduction to the Concepts, Systems, and Applications of Nuclear Processes, 8th Edition, Butterworth-Heinemann, 2020.

2. Samuel Glasstone and Alexander Sesonske, Nuclear Reactor Engineering, 4th Edition, Springer, 1994.
3. J. R. Lamarsh and A. J. Baratta, Introduction to Nuclear Engineering, 4th Edition, Pearson Education, 2017.

REFERENCE BOOKS:

1. Kenneth S. Krane, Introductory Nuclear Physics, Wiley, 1988.
2. John R. Lamarsh, Introduction to Nuclear Reactor Theory, 2nd Edition, American Nuclear Society, 2002.
3. Irving Kaplan, Nuclear Physics, 2nd Edition, Narosa Publishing House, 2002.

Nuclear Fundamentals - II

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE04MT0401	Nuclear Fundamentals - II	Minor	03-00-02	50	50	03

Prerequisite: Nuclear Fundamentals - I.

Course Objectives:

The objectives of this course are: To enable students to understand the principles of nuclear reactor physics, reactor theory and reactor control relevant to nuclear engineering applications.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the concept of neutron transport, diffusion and moderation in nuclear reactors.

CO2: Describe the concept of criticality and multiplication factor in nuclear reactors.

CO3: Analyze reactor kinetics and the role of delayed neutrons in reactor control.

CO4: Explain reactor control mechanisms and reactivity feedback effects.

CO5: Describe the basic classification and working principles of different reactor types.

UNIT I: NEUTRON TRANSPORT AND DIFFUSION

Neutron sources and the neutron life cycle, neutron flux, overview of the neutron transport equation, neutron diffusion theory, diffusion equation, diffusion length, moderation of neutrons, the slowing down process.

UNIT II: REACTOR CRITICALITY

Four factor and six factor formula, multiplication factor, criticality condition, reflector and reflector savings, one group reactor equation, basic concept of buckling and reactor geometry.

UNIT III: REACTOR KINETICS

Point kinetics equations, prompt and delayed neutrons, effective delayed neutron fraction, reactor period, prompt jump approximation, reactor startup and shutdown behavior.

UNIT IV: REACTOR CONTROL AND REACTIVITY FEEDBACK

Reactivity: definition and units, control rods and control mechanisms, temperature and void coefficients of reactivity, xenon and samarium poisoning, basic concept of burnup and fuel depletion.

UNIT V: CLASSIFICATION OF NUCLEAR REACTORS

Classification of reactors based on moderator, coolant, fuel and neutron energy, overview of Pressurized Water

Reactor (PWR), Boiling Water Reactor (BWR), Pressurized Heavy Water Reactor (PHWR) and Fast Breeder Reactor (FBR), comparison of reactor types.

TEXT BOOKS:

1. J. R. Lamarsh and A. J. Baratta, Introduction to Nuclear Engineering, 4th Edition, Pearson Education, 2017.
2. Samuel Glasstone and Alexander Sesonske, Nuclear Reactor Engineering, 4th Edition, Springer, 1994.
3. Weston M. Stacey, Nuclear Reactor Physics, 3rd Edition, Wiley-VCH, 2018.

REFERENCE BOOKS:

1. John R. Lamarsh, Introduction to Nuclear Reactor Theory, 2nd Edition, American Nuclear Society, 2002.
2. Anthony V. Nero Jr., A Guidebook to Nuclear Reactors, University of California Press, 1979.
3. H. S. Bhatia, Nuclear Reactor Theory, Allied Publishers, 1994.

Nuclear Measurements and Instrumentations

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE04MT0501	Nuclear Measurements and Instrumentations	Minor	04-00-02	50	50	04

Prerequisite: Nuclear Fundamentals - I and II, Basic Electronics.

Course Objectives:

The objectives of this course are: To enable students to understand the principles of radiation detection, measurement techniques and instrumentation used for monitoring and control in nuclear engineering systems.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the principles of operation of various radiation detectors used in nuclear measurements.

CO2: Analyze the working of gas-filled detectors and scintillation detectors for radiation measurement.

CO3: Describe semiconductor and neutron detectors and their applications in nuclear measurements.

CO4: Explain nuclear instrumentation systems used for reactor monitoring and control.

CO5: Apply health physics instrumentation and dosimetry techniques for radiation protection.

UNIT I: PRINCIPLES OF RADIATION DETECTION

Interaction of radiation with matter, basic principles of radiation detection, detector characteristics: efficiency, resolution and dead time, classification of radiation detectors, pulse mode and current mode operation.

UNIT II: GAS-FILLED AND SCINTILLATION DETECTORS

Gas-filled detectors: ionization chamber, proportional counter and Geiger-Muller counter - construction and working, scintillation detectors: organic and inorganic scintillators, photomultiplier tubes, basic concept of pulse height analysis.

UNIT III: SEMICONDUCTOR AND NEUTRON DETECTORS

Semiconductor detectors: silicon and germanium detectors, principles and applications, neutron detectors:

overview of BF3 counter, fission chamber and self-powered neutron detectors, applications in reactor instrumentation.

UNIT IV: NUCLEAR INSTRUMENTATION SYSTEMS

Reactor instrumentation: source range, intermediate range and power range instrumentation, signal processing and data acquisition systems, basic concept of reactor protection system, overview of control room instrumentation.

UNIT V: HEALTH PHYSICS AND DOSIMETRY

Radiation dosimetry: concepts and units, personal dosimeters: TLD, film badge and pocket dosimeter, area radiation monitoring instruments, radiation survey meters, basic concept of radiation protection and shielding design.

TEXT BOOKS:

1. Glenn F. Knoll, Radiation Detection and Measurement, 4th Edition, Wiley, 2010.
2. Nicholas Tsoulfanidis, Measurement and Detection of Radiation, 4th Edition, CRC Press, 2015.
3. J. R. Lamarsh and A. J. Baratta, Introduction to Nuclear Engineering, 4th Edition, Pearson Education, 2017.

REFERENCE BOOKS:

1. William J. Price, Nuclear Radiation Detection, 2nd Edition, McGraw Hill, 1964.
2. Herman Cember and Thomas E. Johnson, Introduction to Health Physics, 4th Edition, McGraw Hill, 2009.
3. Gordon R. Gilmore, Practical Gamma-ray Spectrometry, 2nd Edition, Wiley, 2008.

Nuclear Power Plant Engineering

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE04MT0601	Nuclear Power Plant Engineering	Minor	04-00-02	50	50	04

Prerequisite: Thermodynamics, Nuclear Fundamentals - I and II.

Course Objectives:

The objectives of this course are: To enable students to understand the design, operation, safety and economics of nuclear power plants for electricity generation.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the layout, components and working principle of nuclear power plants.

CO2: Analyze thermal hydraulic aspects of nuclear reactor cores and heat transport systems.

CO3: Describe the fuel cycle and fuel management practices in nuclear power plants.

CO4: Analyze safety systems, accident scenarios and safety analysis of nuclear power plants.

CO5: Evaluate economics, waste management and decommissioning aspects of nuclear power plants.

UNIT I: NUCLEAR POWER PLANT LAYOUT AND COMPONENTS

Layout of nuclear power plant, reactor core components, primary and secondary systems, steam generators,

pressurizer, turbine-generator system, comparison of PWR, BWR and PHWR power plant layouts.

UNIT II: THERMAL HYDRAULICS OF NUCLEAR REACTORS

Heat generation in reactor core, heat transfer mechanisms, coolant flow and pressure drop, critical heat flux, thermal design margins, heat transport system design considerations.

UNIT III: NUCLEAR FUEL CYCLE AND FUEL MANAGEMENT

Front end and back end of the nuclear fuel cycle, uranium mining, enrichment and fuel fabrication, in-core fuel management, fuel burnup, overview of reprocessing, closed and open fuel cycles.

UNIT IV: SAFETY AND ACCIDENT ANALYSIS

Nuclear safety principles, defense in depth concept, safety systems: engineered safety features, overview of loss of coolant accident (LOCA), case studies of major nuclear accidents, basic concept of safety analysis and licensing.

UNIT V: ECONOMICS, WASTE MANAGEMENT AND DECOMMISSIONING

Economics of nuclear power generation, cost comparison with other energy sources, radioactive waste classification and management, waste disposal methods, basic concept of decommissioning of nuclear power plants, public perception and regulatory framework.

TEXT BOOKS:

1. J. R. Lamarsh and A. J. Baratta, Introduction to Nuclear Engineering, 4th Edition, Pearson Education, 2017.
2. Neil E. Todreas and Mujid S. Kazimi, Nuclear Systems Volume I: Thermal Hydraulic Fundamentals, 2nd Edition, CRC Press, 2012.
3. Raymond L. Murray and Keith E. Holbert, Nuclear Energy: An Introduction to the Concepts, Systems, and Applications of Nuclear Processes, 8th Edition, Butterworth-Heinemann, 2020.

REFERENCE BOOKS:

1. Samuel Glasstone and Alexander Sesonske, Nuclear Reactor Engineering, 4th Edition, Springer, 1994.
2. Mujid S. Kazimi and Neil E. Todreas, Nuclear Systems Volume II: Elements of Thermal Hydraulic Design, 2nd Edition, CRC Press, 2012.
3. Anthony V. Nero Jr., A Guidebook to Nuclear Reactors, University of California Press, 1979.

Industrial Applications of Nuclear Energy

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE04MP0701	Industrial Applications of Nuclear Energy	Minor	00-08-00	50	50	04

Prerequisite: All core and minor courses of the Nuclear Engineering Systems stream (Nuclear Fundamentals - I and II, Nuclear Measurements and Instrumentations, Nuclear Power Plant Engineering).

Course Objectives:

The objectives of this course are: To enable students to apply the knowledge gained in nuclear engineering courses to explore, analyze and execute a project on industrial and non-power applications of nuclear energy, and to develop practical competency in radioisotope applications, nuclear techniques and safety practices.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Identify and formulate a project related to industrial or non-power applications of nuclear energy.

CO2: Explain the principles and industrial applications of radioisotopes in mechanical and industrial engineering.

CO3: Apply nuclear techniques such as radiography, gauging and tracer technology for industrial problem-solving.

CO4: Analyze safety, regulatory and radiation protection requirements for industrial applications of nuclear energy.

CO5: Prepare technical documentation and present the project work effectively through report writing and oral presentation.

Guidelines:

The project shall focus on industrial applications of nuclear energy such as industrial radiography, radioisotope-based gauging and level/thickness measurement, nuclear well logging, food irradiation and sterilization, tracer applications in industry, and non-destructive testing (NDT) using nuclear techniques. Students shall work individually or in small groups under the guidance of a faculty mentor / industry expert, following relevant safety and regulatory (AERB) guidelines. Continuous evaluation shall be based on periodic reviews of literature survey, methodology and progress, while the end semester evaluation shall comprise a project report and viva-voce / final presentation.

Minor: IOT (Offered by ECS to B.Tech. ME)

Detailed Syllabus

Session: 2026-27

IoT Fundamentals

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE10MT0301	IoT Fundamentals	Minor	03-00-00	50	50	03

Prerequisite: Basic Electronics, Basics of Programming.

Course Objectives:

1: To introduce the fundamental concepts, architecture and applications of the Internet of Things (IoT).
2: To familiarize students with IoT sensors, actuators and communication protocols.
3: To develop understanding of IoT networking technologies and standards.
4: To provide exposure to IoT platforms and prototyping tools.
5: To create awareness about IoT security, privacy and ethical considerations.

Course Outcomes

On successful completion of the course, students will be able to:
CO1: Explain the basic concepts, architecture and applications of IoT.
CO2: Describe various sensors and actuators used in IoT systems.
CO3: Explain IoT communication protocols and networking technologies.
CO4: Describe IoT platforms and prototyping tools used for IoT application development.
CO5: Discuss security, privacy and ethical issues associated with IoT systems.

UNIT I: INTRODUCTION TO IOT

Definition, characteristics and evolution of IoT, IoT architecture: layers and components, IoT ecosystem, overview of applications of IoT in various domains (smart home, healthcare, agriculture, industry).

UNIT II: IOT SENSORS AND ACTUATORS

Overview of classification of sensors used in IoT: temperature, humidity, proximity and motion sensors, actuators: types and applications, sensor characteristics and selection criteria, basic concept of interfacing.

UNIT III: IOT COMMUNICATION PROTOCOLS

Overview of communication protocols: MQTT, CoAP and HTTP, overview of wireless communication

technologies: Wi-Fi, Bluetooth, Zigbee and LoRa, protocol selection criteria for IoT applications.

UNIT IV: IOT NETWORKING AND PLATFORMS

IoT networking topologies, basic concept of gateways and edge devices, overview of IoT platforms (cloud-based and open-source), introduction to IoT prototyping boards (Arduino, ESP8266/32).

UNIT V: IOT SECURITY AND FUTURE TRENDS

Security challenges in IoT, basic concept of authentication and encryption in IoT, privacy considerations, ethical issues in IoT deployment, future trends in IoT technology.

TEXT BOOKS:

1. Arshdeep Bahga and Vijay Madisetti, Internet of Things: A Hands-On Approach, Universities Press, 2015.
2. Raj Kamal, Internet of Things: Architecture and Design Principles, 2nd Edition, McGraw Hill Education, 2020.
3. Adrian McEwen and Hakim Cassimally, Designing the Internet of Things, Wiley, 2013.

REFERENCE BOOKS:

1. Jan Holler et al., From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Academic Press, 2014.
2. Peter Waher, Learning Internet of Things, Packt Publishing, 2015.
3. Vijay Madisetti and Arshdeep Bahga, Internet of Things: A Hands-On Approach, 2nd Edition, VPT Publishing, 2018.

Sensor Interfacing with Arduino and ESP8266

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE10MT0401	Sensor Interfacing with Arduino and ESP8266	Minor	03-00-00	50	50	03

Prerequisite: IoT Fundamentals, Basics of Programming.

Course Objectives:

1: To introduce the architecture and programming of Arduino and ESP8266 platforms.
2: To develop skills in interfacing various sensors with microcontroller boards.
3: To familiarize students with interfacing actuators and output devices.
4: To provide hands-on exposure to wireless data transmission using ESP8266.
5: To enable students to design simple IoT-based embedded applications.

Course Outcomes

On successful completion of the course, students will be able to:
CO1: Explain the architecture and programming environment of Arduino and ESP8266 boards.
CO2: Interface various sensors with Arduino/ESP8266 for data acquisition.
CO3: Interface actuators and output devices with Arduino/ESP8266.
CO4: Implement wireless data transmission using the ESP8266 Wi-Fi module.
CO5: Design and develop simple IoT-based embedded applications using Arduino/ESP8266.

UNIT I: ARDUINO AND ESP8266 ARCHITECTURE

Arduino board architecture and specifications, Arduino IDE and programming basics, ESP8266 architecture and specifications, overview of the ESP8266 programming environment.

UNIT II: SENSOR INTERFACING

Interfacing digital and analog sensors with Arduino, interfacing temperature, humidity, light and motion sensors, reading and processing sensor data, basic concept of calibration.

UNIT III: ACTUATOR AND OUTPUT DEVICE INTERFACING

Interfacing LEDs, relays and motors with Arduino, basic concept of interfacing displays (LCD/OLED), PWM-based control of actuators, basic concept of interrupt handling.

UNIT IV: WIRELESS COMMUNICATION USING ESP8266

Wi-Fi connectivity using ESP8266, sending sensor data to a server/cloud platform, basic concept of MQTT/HTTP communication using ESP8266, overview of data logging and remote monitoring.

UNIT V: IOT EMBEDDED APPLICATION DEVELOPMENT

Integration of sensors, actuators and wireless communication for IoT applications, design of a simple IoT-based monitoring/control system, testing and debugging of embedded IoT applications, case studies of

Arduino/ESP8266 based IoT projects.

TEXT BOOKS:

1. Massimo Banzi and Michael Shiloh, Getting Started with Arduino, 3rd Edition, Maker Media, 2014.
2. Marco Schwartz, Internet of Things with ESP8266, Packt Publishing, 2016.
3. Simon Monk, Programming Arduino: Getting Started with Sketches, 2nd Edition, McGraw Hill Education, 2016.

REFERENCE BOOKS:

1. Jonathan Oxer and Hugh Blemings, Practical Arduino: Cool Projects for Open Source Hardware, Apress, 2009.
2. Neil Kolban, Kolban's Book on ESP8266, Leanpub, 2016.
3. Michael Margolis, Arduino Cookbook, 2nd Edition, O'Reilly Media, 2011.

Cloud Computing Using Raspberry Pi

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE10MT0501	Cloud Computing Using Raspberry Pi	Minor	04-00-00	50	50	04

Prerequisite: Sensor Interfacing with Arduino and ESP8266, Basics of Networking.

Course Objectives:

1: To introduce the architecture and setup of Raspberry Pi as an IoT edge/computing device.
2: To familiarize students with the fundamentals of cloud computing and its service models.
3: To develop skills in connecting Raspberry Pi to cloud platforms for data storage and processing.
4: To enable students to deploy simple applications and services on Raspberry Pi.
5: To provide exposure to remote monitoring and control of IoT systems through cloud integration.

Course Outcomes

On successful completion of the course, students will be able to:
CO1: Explain the architecture and configuration of Raspberry Pi for IoT applications.
CO2: Describe the fundamentals of cloud computing and its service models (IaaS, PaaS, SaaS).
CO3: Connect Raspberry Pi to cloud platforms for data storage and processing.
CO4: Deploy simple applications and web services on Raspberry Pi.
CO5: Implement remote monitoring and control of IoT systems using cloud integration.

UNIT I: RASPBERRY PI FUNDAMENTALS

Raspberry Pi architecture and specifications, Raspberry Pi OS installation and configuration, GPIO pins and interfacing basics, overview of programming Raspberry Pi using Python.

UNIT II: CLOUD COMPUTING FUNDAMENTALS

Definition and characteristics of cloud computing, overview of cloud service models: IaaS, PaaS and SaaS, cloud deployment models: public, private and hybrid, overview of popular cloud platforms (AWS, Google Cloud, Azure, ThingSpeak).

UNIT III: CONNECTING RASPBERRY PI TO CLOUD

Setting up cloud accounts and services for IoT, sending sensor data from Raspberry Pi to cloud platforms, basic concept of MQTT/HTTP-based cloud communication, basic concept of cloud data storage and retrieval.

UNIT IV: APPLICATION DEPLOYMENT ON RASPBERRY PI

Setting up a web server on Raspberry Pi, deploying simple applications and services, overview of containerization (Docker), remote access and management of Raspberry Pi.

UNIT V: REMOTE MONITORING AND CONTROL

Design of a cloud-connected IoT monitoring system, overview of dashboards and visualization tools, remote control of devices through cloud platforms, case studies of cloud-integrated IoT applications using Raspberry Pi.

TEXT BOOKS:

1. Simon Monk, Raspberry Pi Cookbook, 3rd Edition, O'Reilly Media, 2019.
2. Arshdeep Bahga and Vijay Madisetti, Cloud Computing: A Hands-On Approach, Universities Press, 2014.
3. Matt Richardson and Shawn Wallace, Getting Started with Raspberry Pi, 3rd Edition, Maker Media, 2015.

REFERENCE BOOKS:

1. Rajkumar Buyya, Christian Vecchiola and S. Thamarai Selvi, Mastering Cloud Computing, McGraw Hill Education, 2013.

2. Peter Membrey and David Hows, Learning Raspberry Pi, Packt Publishing, 2016.
3. Derek Molloy, Exploring Raspberry Pi, Wiley, 2016.

Data Management and Analytics for IoT

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE10MT0601	Data Management and Analytics for IoT	Minor	04-00-00	50	50	04

Prerequisite: Cloud Computing Using Raspberry Pi, Basic Statistics.

Course Objectives:

1: To introduce the fundamentals of data management for IoT-generated data.
2: To familiarize students with data storage and database technologies used in IoT systems.
3: To develop understanding of data preprocessing and analytics techniques for IoT data.
4: To provide exposure to visualization tools for IoT data analytics.
5: To enable students to apply basic machine learning techniques for IoT data analysis.

Course Outcomes

On successful completion of the course, students will be able to:
CO1: Explain the fundamentals and challenges of data management for IoT-generated data.
CO2: Describe data storage and database technologies (SQL/NoSQL) used in IoT systems.
CO3: Apply data preprocessing techniques for cleaning and preparing IoT data for analysis.
CO4: Apply data visualization tools for analysis and presentation of IoT data.
CO5: Apply basic machine learning techniques for analysis and prediction using IoT data.

UNIT I: FUNDAMENTALS OF IOT DATA MANAGEMENT

Characteristics of IoT data (volume, velocity, variety), data management challenges in IoT, basic concept of the IoT data lifecycle, overview of data management architectures for IoT.

UNIT II: DATA STORAGE TECHNOLOGIES

Overview of relational (SQL) and non-relational (NoSQL) databases, basic concept of time-series databases, data storage considerations for IoT applications, basic concept of edge and cloud data storage.

UNIT III: DATA PREPROCESSING FOR IOT

Data cleaning techniques, handling missing and noisy data, basic concept of data transformation and normalization, overview of feature extraction for IoT data.

UNIT IV: DATA VISUALIZATION AND ANALYTICS

Overview of data visualization tools and dashboards, descriptive analytics for IoT data, basic concept of statistical analysis of IoT data, overview of real-time data visualization.

UNIT V: MACHINE LEARNING FOR IOT DATA

Basic concept of machine learning for IoT applications, overview of supervised and unsupervised learning techniques, application of basic predictive analytics on IoT data, case studies of analytics-driven IoT applications.

TEXT BOOKS:

1. Arshdeep Bahga and Vijay Madisetti, Internet of Things: A Hands-On Approach, Universities Press, 2015.
2. Rajkumar Buyya and Amir Vahid Dastjerdi (Eds.), Internet of Things: Principles and Paradigms, Morgan Kaufmann, 2016.
3. Jules J. Berman, Principles of Big Data: Preparing, Sharing, and Analyzing Complex Information, Morgan Kaufmann, 2013.

REFERENCE BOOKS:

1. Wei-Meng Lee, Python Machine Learning, Wiley, 2019.
2. Jiawei Han, Micheline Kamber and Jian Pei, Data Mining: Concepts and Techniques, 3rd Edition, Morgan Kaufmann, 2011.
3. Rajkumar Buyya, Rodrigo N. Calheiros and Amir Vahid Dastjerdi (Eds.), Big Data: Principles and Paradigms, Morgan Kaufmann, 2016.

Project

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE10MP0701	Project	Minor	00-08-00	50	50	04

Prerequisite: All core and minor courses of the IoT stream (IoT Fundamentals, Sensor Interfacing with Arduino and ESP8266, Cloud Computing Using Raspberry Pi, Data Management and Analytics for IoT).

Course Objectives:

1: To enable students to identify and formulate a real-life problem that can be solved using IoT technologies.
2: To develop skills in designing and integrating IoT hardware and software components for a complete solution.
3: To enable students to implement cloud connectivity and data analytics in their IoT project.
4: To develop skills in testing, validating and troubleshooting IoT systems.
5: To enable students to document and present their IoT project effectively.

Course Outcomes

On successful completion of the course, students will be able to:
CO1: Identify and formulate a real-life engineering problem that can be addressed using IoT technology.
CO2: Design and integrate IoT hardware components (sensors, actuators, microcontrollers) for the chosen problem.
CO3: Implement cloud connectivity and data management for the IoT solution.
CO4: Test, validate and troubleshoot the developed IoT system.
CO5: Prepare technical documentation and present the project work effectively through report writing and oral presentation.

Guidelines:

The project shall involve the design, development and integration of an end-to-end IoT solution encompassing sensing, embedded programming, wireless communication, cloud connectivity and data analytics, related to any of the minor courses (IoT Fundamentals, Sensor Interfacing, Cloud Computing, Data Management and Analytics) or an integration thereof. Students shall work individually or in small groups under the guidance of a faculty mentor. Continuous evaluation shall be based on periodic reviews assessing problem formulation, design and implementation progress, while the end semester evaluation shall comprise the project report and a viva-voce / final demonstration.

Minor: (Offered by CSE to B.Tech. ME)

Detailed Syllabus

Session: 2026-27

Programming for Problem Solving

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26CS01MT0301	Programming for Problem Solving	Minor	03-00-00	50	50	03

Prerequisite: Basic Computer Knowledge.

Course Objectives:

1: To introduce fundamental programming concepts and problem-solving techniques.
2: To develop skills in designing algorithms and flowcharts for problem solving.
3: To familiarize students with control structures, functions and arrays in programming.
4: To develop skills in using pointers and structures for data organization.
5: To enable students to apply programming concepts to solve engineering problems.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain fundamental programming concepts and develop algorithms/flowcharts for problem solving.

CO2: Apply control structures (conditional and looping statements) to solve programming problems.

CO3: Apply functions and arrays for modular and structured programming.

CO4: Apply pointers and structures for efficient data organization and manipulation.

CO5: Develop C programs to solve simple engineering and computational problems.

UNIT I: INTRODUCTION TO PROGRAMMING AND PROBLEM SOLVING

Introduction to computers and programming languages, problem solving techniques: algorithms and flowcharts, pseudocode, structure of a C program, data types, variables and operators.

UNIT II: CONTROL STRUCTURES

Decision making statements: if, if-else and switch-case, looping statements: for, while and do-while, break and continue statements, nested control structures.

UNIT III: FUNCTIONS AND ARRAYS

Functions: definition, declaration and function calls, parameter passing, basic concept of recursion, one-dimensional and two-dimensional arrays, array operations.

UNIT IV: POINTERS AND STRUCTURES

Pointers: basic concept and declaration, pointer arithmetic, basic concept of pointers and arrays, basic concept of structures and unions, overview of structures with functions.

UNIT V: FILE HANDLING AND APPLICATIONS

Introduction to file handling in C, overview of basic file operations, applications of programming to solve simple engineering problems, introduction to modular programming practices.

TEXT BOOKS:

1. E. Balagurusamy, Programming in ANSI C, 8th Edition, McGraw Hill Education, 2019.
2. Yashavant Kanetkar, Let Us C, 17th Edition, BPB Publications, 2020.
3. R. G. Dromey, How to Solve it by Computer, Pearson Education, 1998.

REFERENCE BOOKS:

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, 2nd Edition, Prentice Hall, 1988.
2. Paul Deitel and Harvey Deitel, C: How to Program, 8th Edition, Pearson Education, 2016.
3. Byron Gottfried, Programming with C, 4th Edition, McGraw Hill Education, 2018.

Tools & Techniques of Artificial Intelligence

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26CS01MT0401	Tools & Techniques of Artificial Intelligence	Minor	03-00-00	50	50	03

Prerequisite: Programming for Problem Solving.

Course Objectives:

1: To introduce the fundamental concepts and history of artificial intelligence.

2: To familiarize students with problem-solving techniques and search algorithms used in AI.

3: To develop understanding of knowledge representation techniques in AI.

4: To provide exposure to popular AI tools, frameworks and programming languages.

5: To create awareness about applications and ethical considerations of AI.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts, history and applications of artificial intelligence.

CO2: Apply search algorithms for AI-based problem solving.

CO3: Apply knowledge representation techniques for AI systems.

CO4: Use popular AI tools and frameworks for basic AI application development.

CO5: Discuss applications, limitations and ethical issues related to artificial intelligence.

UNIT I: INTRODUCTION TO ARTIFICIAL INTELLIGENCE

Definition, history and evolution of AI, basic concept of intelligent agents, overview of types of AI: narrow, general and super AI, applications of AI in various domains.

UNIT II: PROBLEM SOLVING AND SEARCH TECHNIQUES

Problem formulation, state space representation, overview of uninformed search techniques: BFS and DFS, basic concept of informed search techniques: A* and greedy best-first search.

UNIT III: KNOWLEDGE REPRESENTATION

Knowledge representation techniques: semantic networks and frames, basic concept of propositional and predicate logic, overview of rule-based systems.

UNIT IV: AI TOOLS AND FRAMEWORKS

Overview of AI programming languages (Python), introduction to popular AI libraries and frameworks (NumPy, Pandas, overview of TensorFlow/Scikit-learn), basic concept of AI development environments.

UNIT V: AI APPLICATIONS AND ETHICS

Applications of AI: overview of expert systems, natural language processing and computer vision, basic concept of robotics and AI, limitations of AI, ethical issues and responsible AI development.

TEXT BOOKS:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 4th Edition, Pearson Education, 2021.

2. Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, 3rd Edition, McGraw Hill Education, 2017.

3. Saroj Kaushik, Artificial Intelligence, Cengage Learning, 2011.

REFERENCE BOOKS:

1. Ethem Alpaydin, Introduction to Machine Learning, 4th Edition, MIT Press, 2020.

2. George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, 6th Edition, Pearson Education, 2008.

3. Nils J. Nilsson, Artificial Intelligence: A New Synthesis, Morgan Kaufmann, 1998.

Exploratory Data Analysis

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26CS01MT0501	Exploratory Data Analysis	Minor	04-00-00	50	50	04

Prerequisite: Programming for Problem Solving, Basic Statistics.

Course Objectives:

1: To introduce the fundamental concepts and process of exploratory data analysis.

2: To develop skills in data cleaning and preprocessing techniques.

3: To familiarize students with statistical and graphical methods for data exploration.

4: To provide exposure to data visualization tools and techniques.

5: To enable students to apply EDA techniques to real-world datasets.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts and importance of exploratory data analysis.

CO2: Apply data cleaning and preprocessing techniques to prepare data for analysis.

CO3: Apply statistical methods for univariate and bivariate data analysis.

CO4: Apply data visualization techniques for effective data exploration.

CO5: Perform exploratory data analysis on real-world datasets using appropriate tools.

UNIT I: INTRODUCTION TO EXPLORATORY DATA ANALYSIS

Definition and importance of EDA, data types and measurement scales, basic concept of the EDA process and workflow, overview of tools used for EDA (Python: Pandas, NumPy).

UNIT II: DATA CLEANING AND PREPROCESSING

Handling missing data, basic concept of outlier detection and treatment, data transformation techniques, overview of data normalization and standardization.

UNIT III: STATISTICAL METHODS FOR DATA ANALYSIS

Descriptive statistics: measures of central tendency and dispersion, basic concept of univariate analysis, overview of bivariate and multivariate analysis, basic concept of correlation and covariance.

UNIT IV: DATA VISUALIZATION TECHNIQUES

Overview of visualization techniques: histograms, box plots and scatter plots, basic concept of visualization libraries (Matplotlib, Seaborn), overview of dashboard-based visualization.

UNIT V: APPLIED EXPLORATORY DATA ANALYSIS

EDA case studies on real-world datasets, basic concept of feature engineering, hypothesis generation through EDA, reporting and communicating EDA findings.

TEXT BOOKS:

1. Wes McKinney, Python for Data Analysis, 3rd Edition, O'Reilly Media, 2022.
2. Jake VanderPlas, Python Data Science Handbook, 2nd Edition, O'Reilly Media, 2022.
3. John W. Tukey, Exploratory Data Analysis, Addison-Wesley, 1977.

REFERENCE BOOKS:

1. Hadley Wickham and Garrett Grolemund, R for Data Science, O'Reilly Media, 2017.
2. Suresh Kumar Mukhiya and Usman Ahmed, Hands-On Exploratory Data Analysis with Python, Packt Publishing, 2020.
3. Peter Bruce and Andrew Bruce, Practical Statistics for Data Scientists, 2nd Edition, O'Reilly Media, 2020.

Fundamentals of Machine Learning

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26CS01MT0601	Fundamentals of Machine Learning	Minor	04-00-00	50	50	04

Prerequisite: Exploratory Data Analysis, Programming for Problem Solving.

Course Objectives:

1: To introduce the fundamental concepts and types of machine learning.
2: To develop understanding of supervised learning algorithms and their applications.
3: To develop understanding of unsupervised learning algorithms and their applications.
4: To familiarize students with model evaluation and performance metrics.
5: To enable students to implement basic machine learning models using programming tools.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts and types of machine learning.
CO2: Apply supervised learning algorithms for classification and regression problems.
CO3: Apply unsupervised learning algorithms for clustering and pattern discovery.
CO4: Evaluate machine learning models using appropriate performance metrics.
CO5: Implement basic machine learning models using programming tools/libraries.

UNIT I: INTRODUCTION TO MACHINE LEARNING

Definition and overview of types of machine learning: supervised, unsupervised and reinforcement learning, machine learning workflow, applications of machine learning.

UNIT II: SUPERVISED LEARNING - REGRESSION AND CLASSIFICATION

Basic concept of linear regression, basic concept of logistic regression, overview of decision trees, basic concept of k-nearest neighbors (KNN).

UNIT III: SUPERVISED LEARNING - ADVANCED ALGORITHMS

Basic concept of support vector machines, basic concept of the naive Bayes classifier, overview of ensemble methods: bagging and boosting.

UNIT IV: UNSUPERVISED LEARNING

Clustering techniques: basic concept of k-means clustering, overview of hierarchical clustering, basic concept of dimensionality reduction: principal component analysis (PCA).

UNIT V: MODEL EVALUATION AND IMPLEMENTATION

Basic concept of model evaluation metrics: accuracy, precision, recall and F1-score, basic concept of cross-validation, overfitting and underfitting, implementation of ML models using Python (overview of Scikit-learn).

TEXT BOOKS:

1. Tom M. Mitchell, Machine Learning, McGraw Hill Education, 1997.
2. Aurelien Geron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 3rd Edition, O'Reilly Media, 2022.
3. Ethem Alpaydin, Introduction to Machine Learning, 4th Edition, MIT Press, 2020.

REFERENCE BOOKS:

1. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
2. Trevor Hastie, Robert Tibshirani and Jerome Friedman, The Elements of Statistical Learning, 2nd Edition, Springer, 2009.
3. Sebastian Raschka and Vahid Mirjalili, Python Machine Learning, 3rd Edition, Packt Publishing, 2019.

Project

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26CS01MP0701	Project	Minor	00-08-00	50	50	04

Prerequisite: All core and minor courses of the stream (Programming for Problem Solving, Tools & Techniques of Artificial Intelligence, Exploratory Data Analysis, Fundamentals of Machine Learning).

Course Objectives:

1: To enable students to identify and formulate a real-life problem that can be solved using AI/ML/data analysis techniques.

2: To develop skills in collecting, preprocessing and exploring data for the chosen problem.

3: To enable students to design and implement an appropriate AI/ML model/solution.

4: To develop skills in evaluating and validating the developed solution.

5: To enable students to document and present their project effectively.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Identify and formulate a real-life engineering problem that can be addressed using programming, AI, data analysis or machine learning techniques.

CO2: Collect, preprocess and explore data relevant to the identified problem.

CO3: Design and implement an appropriate computational/AI/ML solution for the identified problem.

CO4: Evaluate and validate the performance of the developed solution.

CO5: Prepare technical documentation and present the project work effectively through report writing and oral presentation.

Guidelines:

The project may be based on any one or an integration of the minor courses (Programming for Problem Solving, Tools & Techniques of Artificial Intelligence, Exploratory Data Analysis, Fundamentals of Machine Learning), applied to a real-life engineering or interdisciplinary problem. Students shall work individually or in small groups under the guidance of a faculty mentor. Continuous evaluation shall be based on periodic reviews assessing problem formulation, methodology and implementation progress, while the end semester evaluation shall comprise the project report and a viva-voce / final presentation.

Minor: (Offered by ECE to B.Tech. ME)

Detailed Syllabus

Session: 2026-27

Fundamentals of Communication Engineering

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE05MT0301	Fundamentals of Communication Engineering	Minor	03-00-00	50	50	03

Prerequisite: Basic Electronics, Engineering Mathematics.

Course Objectives:

1: To introduce the fundamental concepts and building blocks of communication systems.

2: To develop understanding of analog modulation techniques.

3: To develop understanding of digital modulation techniques.

4: To familiarize students with the principles of information theory and channel capacity.

5: To provide exposure to wired and wireless communication media and systems.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts and building blocks of a communication system.

CO2: Analyze analog modulation techniques (AM, FM, PM) for signal transmission.

CO3: Analyze digital modulation techniques for signal transmission.

CO4: Explain the basic principles of information theory and channel capacity.

CO5: Describe wired and wireless communication media and systems.

UNIT I: INTRODUCTION TO COMMUNICATION SYSTEMS

Elements of a communication system, need for modulation, classification of signals, basic concept of noise in communication systems, overview of communication system performance parameters.

UNIT II: ANALOG MODULATION TECHNIQUES

Amplitude modulation (AM): principle and generation, basic concept of frequency modulation (FM) and phase modulation (PM), comparison of analog modulation techniques, basic concept of AM/FM receivers.

UNIT III: DIGITAL MODULATION TECHNIQUES

Introduction to digital communication, basic concept of sampling and quantization, overview of digital modulation techniques: ASK, FSK and PSK, basic concept of pulse code modulation (PCM).

UNIT IV: INFORMATION THEORY AND CHANNEL CAPACITY

Basic concept of information and entropy, basic concept of Shannon's channel capacity theorem, overview of error control coding, basic concept of source coding.

UNIT V: COMMUNICATION MEDIA AND SYSTEMS

Overview of wired communication media: twisted pair, coaxial cable and optical fiber, wireless communication systems: basic concept of radio, microwave and satellite communication, introduction to mobile communication systems.

TEXT BOOKS:

1. Simon Haykin, Communication Systems, 5th Edition, Wiley, 2009.
2. B. P. Lathi and Zhi Ding, Modern Digital and Analog Communication Systems, 4th Edition, Oxford University Press, 2010.
3. Herbert Taub, Donald L. Schilling and Goutam Saha, Principles of Communication Systems, 3rd Edition, McGraw Hill Education, 2013.

REFERENCE BOOKS:

1. John G. Proakis and Masoud Salehi, Communication Systems Engineering, 2nd Edition, Pearson Education, 2002.
2. Wayne Tomasi, Electronic Communications Systems, 5th Edition, Pearson Education, 2013.
3. A. Bruce Carlson and Paul B. Crilly, Communication Systems: An Introduction to Signals and Noise in Electrical Communication, 5th Edition, McGraw Hill Education, 2010.

Sensors for Intelligent Instrumentation

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE05MT0401	Sensors for Intelligent Instrumentation	Minor	03-00-00	50	50	03

Prerequisite: Fundamentals of Communication Engineering, Basic Electronics.

Course Objectives:

1: To introduce the fundamental concepts and classification of sensors used in instrumentation.
2: To develop understanding of physical and mechanical sensors and their working principles.
3: To develop understanding of electrical and electronic sensors and their working principles.
4: To familiarize students with smart sensors and sensor interfacing techniques.
5: To provide exposure to applications of sensors in intelligent instrumentation systems.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts, classification and characteristics of sensors.

CO2: Describe the working principles of physical and mechanical sensors.

CO3: Describe the working principles of electrical, optical and electronic sensors.

CO4: Explain smart sensors and sensor interfacing techniques with microcontrollers/systems.

CO5: Apply sensor technology for intelligent instrumentation and measurement applications.

UNIT I: FUNDAMENTALS OF SENSORS

Definition and classification of sensors, sensor characteristics: sensitivity, accuracy, linearity and response time - basic concept, sensor selection criteria, role of sensors in instrumentation systems.

UNIT II: PHYSICAL AND MECHANICAL SENSORS

Basic concept of temperature sensors: thermocouple, RTD and thermistor, overview of pressure and force sensors, basic concept of displacement and position sensors.

UNIT III: ELECTRICAL, OPTICAL AND ELECTRONIC SENSORS

Basic concept of capacitive and inductive sensors, overview of optical sensors and photodetectors, basic concept of chemical and gas sensors, basic concept of biosensors.

UNIT IV: SMART SENSORS AND INTERFACING

Concept of smart sensors, basic concept of sensor signal conditioning, sensor interfacing with microcontrollers, basic concept of wireless sensor networks.

UNIT V: APPLICATIONS OF SENSORS IN INSTRUMENTATION

Sensor applications in industrial automation, overview of sensor applications in healthcare and biomedical instrumentation, basic concept of sensor fusion, case studies of intelligent instrumentation systems.

TEXT BOOKS:

1. D. Patranabis, Sensors and Transducers, 2nd Edition, PHI Learning, 2003.
2. Jacob Fraden, Handbook of Modern Sensors: Physics, Designs, and Applications, 5th Edition, Springer, 2016.
3. D. V. S. Murty, Transducers and Instrumentation, 2nd Edition, PHI Learning, 2008.

REFERENCE BOOKS:

1. Ramon Pallas-Areny and John G. Webster, Sensors and Signal Conditioning, 2nd Edition, Wiley, 2001.
2. John P. Bentley, Principles of Measurement Systems, 4th Edition, Pearson Education, 2005.
3. Nathan Ida, Sensors, Actuators, and Their Interfaces, 2nd Edition, SciTech Publishing, 2020.

IoT for Industrial Application

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE05MT0501	IoT for Industrial Application	Minor	04-00-00	50	50	04

Prerequisite: Sensors for Intelligent Instrumentation, Fundamentals of Communication Engineering.

Course Objectives:

1: To introduce the fundamental concepts and architecture of Industrial IoT (IIoT).

2: To develop understanding of industrial sensors, actuators and communication protocols.

3: To familiarize students with IIoT networking and connectivity technologies.

4: To develop understanding of data acquisition and edge/cloud computing for industrial applications.

5: To provide exposure to IIoT security and real-world industrial application case studies.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts and architecture of Industrial IoT (IIoT).

CO2: Describe industrial sensors, actuators and communication protocols used in IIoT systems.

CO3: Explain IIoT networking and connectivity technologies.

CO4: Describe data acquisition, edge computing and cloud computing for industrial IoT applications.

CO5: Discuss IIoT security challenges and apply IIoT concepts to industrial application case studies.

UNIT I: INTRODUCTION TO INDUSTRIAL IOT

Definition and scope of Industrial IoT (IIoT), difference between IoT and IIoT, IIoT architecture: layers and components, applications of IIoT in manufacturing and process industries.

UNIT II: INDUSTRIAL SENSORS, ACTUATORS AND PROTOCOLS

Overview of industrial sensors and actuators, overview of industrial communication protocols: Modbus, PROFIBUS and industrial Ethernet, basic concept of SCADA and PLC integration with IIoT.

UNIT III: IIOT NETWORKING AND CONNECTIVITY

Industrial wireless technologies: overview of Wi-Fi, Zigbee and LoRa for industrial use, basic concept of IIoT gateways and edge devices, overview of network topologies for industrial IoT.

UNIT IV: DATA ACQUISITION AND EDGE/CLOUD COMPUTING

Data acquisition systems for IIoT, basic concept of edge computing for industrial applications, overview of cloud platforms for IIoT, basic concept of data analytics for industrial IoT.

UNIT V: IIOT SECURITY AND APPLICATIONS

Security challenges in IIoT, basic concept of IIoT security measures, overview of applications of IIoT: predictive maintenance, asset tracking and process monitoring, case studies of IIoT implementation in industry.

TEXT BOOKS:

1. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016.

2. Sabina Jeschke, Christian Brecher, Houbing Song and Danda B. Rawat (Eds.), Industrial Internet of Things: Cybermanufacturing Systems, Springer, 2017.

3. Arshdeep Bahga and Vijay Madisetti, Internet of Things: A Hands-On Approach, Universities Press, 2015.

REFERENCE BOOKS:

1. Jan Holler et al., From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Academic Press, 2014.

2. Pethuru Raj and Anupama C. Raman, The Internet of Things: Enabling Technologies, Platforms, and Use

Cases, CRC Press, 2017.

3. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 4th Edition, Pearson Education, 2015.

Future Generation Networks

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE05MT0601	Future Generation Networks	Minor	04-00-00	50	50	04

Prerequisite: Fundamentals of Communication Engineering, IoT for Industrial Application.

Course Objectives:

1: To introduce the evolution and architecture of mobile and wireless communication networks.

2: To develop understanding of 4G and 5G network technologies.

3: To familiarize students with the architecture and applications of 6G and beyond networks.

4: To develop understanding of software-defined networking (SDN) and network function virtualization (NFV).

5: To provide exposure to emerging trends in future generation networks.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the evolution and architecture of mobile and wireless communication networks.

CO2: Describe the architecture and key technologies of 4G and 5G networks.

CO3: Explain the architecture and applications of 6G and beyond wireless networks.

CO4: Describe software-defined networking (SDN) and network function virtualization (NFV) concepts.

CO5: Discuss emerging trends and applications of future generation networks.

UNIT I: EVOLUTION OF WIRELESS NETWORKS

Overview of the evolution of mobile communication generations (1G to 5G), basic cellular network concepts, network architecture evolution, key drivers for future generation networks.

UNIT II: 4G AND 5G NETWORK TECHNOLOGIES

Basic concept of 4G network architecture (LTE), overview of 5G network architecture and key technologies: massive MIMO and mmWave, basic concept of 5G use cases: eMBB, URLLC and mMTC.

UNIT III: 6G AND BEYOND NETWORKS

Overview of the vision and requirements of 6G networks, basic concept of emerging technologies for 6G: terahertz communication and AI-native networks, overview of applications of 6G.

UNIT IV: SOFTWARE-DEFINED NETWORKING AND NFV

Basic concept of software-defined networking (SDN), overview of SDN architecture and controllers, basic concept of network function virtualization (NFV), basic concept of network slicing.

UNIT V: EMERGING TRENDS IN FUTURE NETWORKS

Basic concept of the Internet of Everything (IoE), overview of integration of AI/ML with networks, basic concept of satellite and non-terrestrial networks, case studies of future network deployments.

TEXT BOOKS:

1. Theodore S. Rappaport, Wireless Communications: Principles and Practice, 2nd Edition, Pearson Education, 2002.

2. Afif Osseiran, Jose F. Monserrat and Patrick Marsch (Eds.), 5G Mobile and Wireless Communications Technology, Cambridge University Press, 2016.

3. Erik Dahlman, Stefan Parkvall and Johan Skold, 5G NR: The Next Generation Wireless Access Technology, 2nd Edition, Academic Press, 2020.

REFERENCE BOOKS:

1. Martin Sauter, From GSM to LTE-Advanced Pro and 5G, 4th Edition, Wiley, 2021.

2. Ian F. Akyildiz et al., 6G and Beyond: The Future of Wireless Communications Systems, IEEE Press, 2021.

3. William Stallings, Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud, Pearson Education, 2015.

Project

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE05MP0701	Project	Minor	00-08-00	50	50	04

Prerequisite: All core and minor courses of the stream (Fundamentals of Communication Engineering, Sensors for Intelligent Instrumentation, IoT for Industrial Application, Future Generation Networks).

Course Objectives:

1: To enable students to identify and formulate a real-life problem related to communication, sensing or networked systems.

2: To develop skills in designing and integrating communication/sensor/IoT hardware and software components.

3: To enable students to implement networking/connectivity solutions for the chosen problem.

4: To develop skills in testing, validating and troubleshooting the developed system.

5: To enable students to document and present their project effectively.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Identify and formulate a real-life engineering problem related to communication, sensing or networked systems.

CO2: Design and integrate communication/sensor/IoT hardware and software components for the chosen problem.

CO3: Implement networking/connectivity solutions for the developed system.

CO4: Test, validate and troubleshoot the developed system.

CO5: Prepare technical documentation and present the project work effectively through report writing and oral presentation.

Guidelines:

The project may be based on any one or an integration of the minor courses (Fundamentals of Communication Engineering, Sensors for Intelligent Instrumentation, IoT for Industrial Application, Future Generation Networks), applied to a real-life engineering problem. Students shall work individually or in small groups under the guidance of a faculty mentor. Continuous evaluation shall be based on periodic reviews assessing problem formulation, methodology and implementation progress, while the end semester evaluation shall comprise the project report and a viva-voce / final presentation.

Multi-Disciplinary Minor (MDM) offered by ME to other department students: Manufacturing Systems and Productivity Engineering

Detailed Syllabus

Session: 2026-27

Basics of Mechanical Engineering

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26ES04TH0307	Basics of Mechanical Engineering	MDM	03-00-00	50	50	03

Prerequisite: Basic Physics, Basic Mathematics (10+2 level).

Course Objectives:

The objectives of this course are: To enable students from other engineering disciplines to understand the fundamental concepts of mechanical engineering, including materials, mechanisms, thermal systems, fluid mechanics and manufacturing processes, for interdisciplinary application.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain basic concepts of engineering materials and their mechanical properties.

CO2: Describe fundamentals of mechanisms, power transmission and basic machine elements.

CO3: Explain basic concepts of thermodynamics and applications of thermal engineering systems.

CO4: Describe fundamentals of fluid mechanics and its engineering applications.

CO5: Explain basic manufacturing processes used in mechanical component production.

UNIT I: ENGINEERING MATERIALS

Classification of engineering materials, mechanical properties: strength, hardness, ductility and toughness, structure-property relationship, ferrous and non-ferrous metals, introduction to composites, ceramics and polymers, selection of materials for engineering applications.

UNIT II: MECHANISMS AND MACHINE ELEMENTS

Basic concepts of mechanisms, types of motion, simple mechanisms: four bar chain and slider crank mechanism, power transmission elements: belts, gears and chains - basic concept, introduction to bearings, keys and couplings.

UNIT III: THERMAL ENGINEERING

Basic concepts of thermodynamics: system, process, overview of first and second law of thermodynamics, introduction to IC engines, boilers, refrigeration and air conditioning systems, applications of thermal engineering in industry.

UNIT IV: FLUID MECHANICS

Properties of fluids, basic concepts of fluid statics and dynamics, overview of Bernoulli's equation, introduction to pumps and hydraulic machines, applications of fluid mechanics in engineering systems.

UNIT V: MANUFACTURING PROCESSES

Overview of manufacturing processes: casting, forming, machining, welding and joining, introduction to CNC machines, basic concepts of quality control in manufacturing, overview of Industry 4.0 in manufacturing.

TEXT BOOKS:

1. R. K. Rajput, A Textbook of Basic Mechanical Engineering, 2nd Edition, Laxmi Publications, 2013.
2. G. Shanmugam and S. Ravindran, Basic Mechanical Engineering, McGraw Hill Education, 2013.
3. Pravin Kumar, Basic Mechanical Engineering, Pearson Education, 2013.

REFERENCE BOOKS:

1. William D. Callister and David G. Rethwisch, Materials Science and Engineering: An Introduction, 10th Edition, Wiley, 2018.
2. P. K. Nag, Engineering Thermodynamics, 6th Edition, McGraw Hill Education, 2017.
3. R. K. Bansal, A Textbook of Fluid Mechanics and Hydraulic Machines, 9th Edition, Laxmi Publications, 2010.

Manufacturing Engineering

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26ES04TH0407	Manufacturing Engineering	MDM	03-00-00	50	50	03

Prerequisite: Basics of Mechanical Engineering.

Course Objectives:

The objectives of this course are: To enable students to understand the principles of various manufacturing processes including casting, forming, machining and joining, for the production of engineering components.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the principles and classification of manufacturing processes.

CO2: Describe casting processes and their applications in component manufacturing.

CO3: Analyze metal forming processes for shaping engineering components.

CO4: Explain machining processes and basic machine tool operations.

CO5: Describe welding and joining processes used in manufacturing.

UNIT I: INTRODUCTION TO MANUFACTURING

Classification of manufacturing processes, manufacturing process selection criteria, overview of manufacturing systems, role of manufacturing engineering in product development, introduction to manufacturing economics.

UNIT II: CASTING PROCESSES

Sand casting: pattern making, mould making, gating and risering system, special casting processes: die casting, investment casting and centrifugal casting - overview, casting defects and remedies.

UNIT III: METAL FORMING PROCESSES

Classification of forming processes, basic principles of forging, rolling, extrusion and drawing, sheet metal forming operations: shearing, bending and deep drawing - overview, applications of forming processes.

UNIT IV: MACHINING PROCESSES

Basic principles of metal cutting, cutting tools and tool geometry, overview of machine tools: lathe, milling, drilling and grinding, introduction to CNC machining, basic concepts of machining economics.

UNIT V: WELDING AND JOINING PROCESSES

Classification of welding processes, basic principles of arc welding and gas welding, overview of resistance welding, brazing and soldering, welding defects and quality control, introduction to modern joining techniques.

TEXT BOOKS:

1. P. N. Rao, Manufacturing Technology: Foundry, Forming and Welding, 5th Edition, McGraw Hill Education, 2018.
2. P. N. Rao, Manufacturing Technology: Metal Cutting and Machine Tools, 4th Edition, McGraw Hill Education, 2018.
3. Amitabha Ghosh and Asok Kumar Mallik, Manufacturing Science, 2nd Edition, East West Press, 2010.

REFERENCE BOOKS:

1. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 6th Edition, Wiley, 2015.
2. Serope Kalpakjian and Steven R. Schmid, Manufacturing Engineering and Technology, 7th Edition, Pearson Education, 2014.
3. B. S. Raghuwanshi, Workshop Technology (Manufacturing Processes), 15th Edition, Dhanpat Rai & Co., 2013.

Productivity Improvement Techniques

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26ES04TH0507	Productivity Improvement Techniques	MDM	03-00-00	50	50	03

Prerequisite: Manufacturing Engineering, Basics of Mechanical Engineering.

Course Objectives:

The objectives of this course are: To enable students to understand and apply various productivity improvement techniques, including work study, statistical quality control, and lean manufacturing tools, for enhancing industrial productivity.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the concept, scope and importance of productivity and productivity improvement techniques.

CO2: Apply method study techniques for improving work methods and processes.

CO3: Apply work measurement techniques for determining standard time.

CO4: Apply statistical quality control techniques for process and product quality improvement.

CO5: Apply lean manufacturing and value engineering concepts for productivity enhancement.

UNIT I: INTRODUCTION TO PRODUCTIVITY

Concept and definition of productivity, productivity indices, factors affecting productivity, overview of productivity improvement techniques, work study: definition, scope and objectives.

UNIT II: METHOD STUDY

Method study procedure, recording techniques: process charts, flow diagrams and string diagrams, motion study, principles of motion economy, basic concept of micro-motion study, developing and installing improved method.

UNIT III: WORK MEASUREMENT

Work measurement techniques: time study, standard time determination, rating and allowances, work sampling, overview of predetermined motion time systems (PMTS), applications of work measurement in industry.

UNIT IV: STATISTICAL QUALITY CONTROL

Concept of quality control, control charts for variables and attributes, basic concept of process capability analysis, overview of acceptance sampling: single and double sampling plans, basic concepts of Total Quality Management (TQM).

UNIT V: LEAN MANUFACTURING AND VALUE ENGINEERING

Lean manufacturing principles, types of waste (Muda), overview of 5S, Kaizen and Just-In-Time (JIT), value engineering: concept and function analysis, applications of value engineering, case studies in productivity improvement.

TEXT BOOKS:

1. International Labour Office, Introduction to Work Study, 4th Revised Edition, ILO, 2008.
2. S. Dalela and Saurabh Saurabh, Work Study and Ergonomics, S. K. Kataria & Sons, 2012.
3. Douglas C. Montgomery, Introduction to Statistical Quality Control, 8th Edition, Wiley, 2019.

REFERENCE BOOKS:

1. James R. Evans and William M. Lindsay, The Management and Control of Quality, 9th Edition, Cengage Learning, 2016.
2. Jeffrey K. Liker, The Toyota Way, McGraw Hill, 2004.
3. Lawrence D. Miles, Techniques of Value Analysis and Engineering, 3rd Edition, Lawrence D. Miles Value Foundation, 1989.

Smart Manufacturing and Industry 4.0

Course Code	Course Title	Category	L-P-S	CA	FE	Credits

26ES04TH0607	Smart Manufacturing and Industry 4.0	MDM	03-00-00	50	50	03

Prerequisite: Manufacturing Engineering, Basics of Mechanical Engineering.

Course Objectives:

The objectives of this course are: To enable students to understand the concepts, technologies and applications of Industry 4.0 and smart manufacturing systems for enhancing manufacturing efficiency and flexibility.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the concepts, evolution and pillars of Industry 4.0 in manufacturing.

CO2: Describe the role of Internet of Things (IoT) and cyber-physical systems in smart manufacturing.

CO3: Explain the concepts of automation, robotics and flexible manufacturing systems.

CO4: Describe the role of big data analytics and artificial intelligence in smart manufacturing.

CO5: Explain the concept of digital twin, cloud manufacturing and additive manufacturing in Industry 4.0.

UNIT I: INTRODUCTION TO INDUSTRY 4.0

Evolution of industrial revolutions, concept and pillars of Industry 4.0, smart factory concept, benefits and challenges of Industry 4.0 implementation, overview of Industry 4.0 readiness and maturity models.

UNIT II: INTERNET OF THINGS AND CYBER-PHYSICAL SYSTEMS

Introduction to Internet of Things (IoT) and Industrial Internet of Things (IIoT), sensors and actuators for smart manufacturing, cyber-physical systems: concept and architecture, overview of communication protocols for IoT.

UNIT III: AUTOMATION AND ROBOTICS IN MANUFACTURING

Basics of industrial automation, overview of PLC and SCADA systems, industrial robots: classification and applications, flexible manufacturing systems (FMS): concept and components, basic concept of automated guided vehicles (AGVs).

UNIT IV: BIG DATA ANALYTICS AND ARTIFICIAL INTELLIGENCE IN MANUFACTURING

Introduction to big data in manufacturing, data acquisition and analytics for predictive maintenance, basic concepts of machine learning and artificial intelligence in manufacturing, overview of condition monitoring and fault diagnosis.

UNIT V: DIGITAL TWIN, CLOUD AND ADDITIVE MANUFACTURING

Digital twin: concept and applications in manufacturing, cloud manufacturing: concept and benefits, introduction to additive manufacturing and its role in Industry 4.0, cyber security basics for smart manufacturing systems, case studies of smart factories.

TEXT BOOKS:

1. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016.

2. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 4th Edition, Pearson Education, 2015.

3. Sabina Jeschke, Christian Brecher, Houbing Song and Danda B. Rawat (Eds.), Industrial Internet of Things: Cybermanufacturing Systems, Springer, 2017.

REFERENCE BOOKS:

1. Yoram Koren, The Global Manufacturing Revolution, Wiley, 2010.

2. Amit Bandyopadhyay and Susmita Bose, Additive Manufacturing, 2nd Edition, CRC Press, 2019.
3. Rainer Drath (Ed.), Industrie 4.0: Hype or Revolution?, Springer, 2018.

Multi-Disciplinary Minor (MDM) offered by EE to ME students: Basics of Nuclear Systems

Detailed Syllabus

Session: 2026-27

Nuclear Concepts-I

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE04TH0307	Nuclear Concepts-I	MDM	03-00-00	50	50	03

Prerequisite: Basic Physics, Basic Mathematics (10+2 level).

Course Objectives:

The objectives of this course are: To enable students from other engineering disciplines to understand the fundamental concepts of atomic and nuclear physics, radioactivity and nuclear reactions relevant to nuclear engineering systems.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the basic atomic and nuclear structure and properties of the nucleus.

CO2: Describe the phenomenon of radioactivity, decay laws and types of radioactive decay.

CO3: Explain nuclear reactions, cross-sections and interaction of radiation with matter.

CO4: Describe the process of nuclear fission and fusion and the associated energy release.

CO5: Explain the basic classification and working principle of nuclear reactors.

UNIT I: ATOMIC AND NUCLEAR STRUCTURE

Atomic models, structure of the nucleus, nuclear binding energy, mass defect, nuclear stability, isotopes, isobars and isotones, basic concept of nuclear forces.

UNIT II: RADIOACTIVITY

Radioactivity: alpha, beta and gamma decay, decay law, half-life, mean life, activity, radioactive equilibrium, natural and artificial radioactivity, units of radioactivity.

UNIT III: NUCLEAR REACTIONS

Types of nuclear reactions, Q-value of nuclear reactions, concept of cross-section, neutron interactions: scattering, absorption and fission, overview of interaction of gamma rays and charged particles with matter.

UNIT IV: NUCLEAR FISSION AND FUSION

Fission process: mechanism, energy release and fission products, chain reaction, concept of criticality, fusion process: basic concept and conditions, comparison of fission and fusion, applications of nuclear fission and fusion.

UNIT V: INTRODUCTION TO NUCLEAR REACTORS

Basic principle of a nuclear reactor, classification of reactors based on moderator, coolant and fuel, overview of

PWR, BWR and PHWR, applications of nuclear reactors for power and non-power purposes.

TEXT BOOKS:

1. Raymond L. Murray and Keith E. Holbert, Nuclear Energy: An Introduction to the Concepts, Systems, and Applications of Nuclear Processes, 8th Edition, Butterworth-Heinemann, 2020.
2. J. R. Lamarsh and A. J. Baratta, Introduction to Nuclear Engineering, 4th Edition, Pearson Education, 2017.
3. Samuel Glasstone and Alexander Sesonske, Nuclear Reactor Engineering, 4th Edition, Springer, 1994.

REFERENCE BOOKS:

1. Kenneth S. Krane, Introductory Nuclear Physics, Wiley, 1988.
2. Irving Kaplan, Nuclear Physics, 2nd Edition, Narosa Publishing House, 2002.
3. John R. Lamarsh, Introduction to Nuclear Reactor Theory, 2nd Edition, American Nuclear Society, 2002.

Nuclear Concepts-II

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE04TH0407	Nuclear Concepts-II	MDM	03-00-00	50	50	03

Prerequisite: Nuclear Concepts-I.

Course Objectives:

The objectives of this course are: To enable students to understand the principles of nuclear reactor physics, reactor control and the nuclear fuel cycle relevant to nuclear engineering systems.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the concept of neutron transport, diffusion and moderation in nuclear reactors.

CO2: Describe the concept of criticality and the multiplication factor in nuclear reactors.

CO3: Explain reactor kinetics and reactor control mechanisms.

CO4: Describe the nuclear fuel cycle and fuel management practices.

CO5: Explain the basic layout and working of nuclear power plants.

UNIT I: NEUTRON TRANSPORT AND DIFFUSION

Neutron sources and the neutron life cycle, neutron flux, basic concept of neutron diffusion theory, moderation of neutrons, overview of the slowing down process.

UNIT II: REACTOR CRITICALITY

Four factor formula, multiplication factor, criticality condition, basic concept of reflector and reflector savings, factors affecting criticality.

UNIT III: REACTOR KINETICS AND CONTROL

Basic concept of reactor kinetics, overview of prompt and delayed neutrons, reactivity: definition and units, control rods and control mechanisms, basic concept of temperature and void coefficients.

UNIT IV: NUCLEAR FUEL CYCLE

Front end and back end of the nuclear fuel cycle, uranium mining and enrichment, fuel fabrication, basic concept of in-core fuel management, overview of reprocessing, closed and open fuel cycles.

UNIT V: NUCLEAR POWER PLANT LAYOUT

Layout of a nuclear power plant, reactor core components, overview of primary and secondary systems, comparison of PWR, BWR and PHWR power plant layouts, basic economics of nuclear power.

TEXT BOOKS:

1. J. R. Lamarsh and A. J. Baratta, Introduction to Nuclear Engineering, 4th Edition, Pearson Education, 2017.
2. Samuel Glasstone and Alexander Sesonske, Nuclear Reactor Engineering, 4th Edition, Springer, 1994.
3. Raymond L. Murray and Keith E. Holbert, Nuclear Energy: An Introduction to the Concepts, Systems, and Applications of Nuclear Processes, 8th Edition, Butterworth-Heinemann, 2020.

REFERENCE BOOKS:

1. Weston M. Stacey, Nuclear Reactor Physics, 3rd Edition, Wiley-VCH, 2018.
2. John R. Lamarsh, Introduction to Nuclear Reactor Theory, 2nd Edition, American Nuclear Society, 2002.
3. Anthony V. Nero Jr., A Guidebook to Nuclear Reactors, University of California Press, 1979.

Basics of Nuclear Measurements

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE04TH0507	Basics of Nuclear Measurements	MDM	03-00-00	50	50	03

Prerequisite: Nuclear Concepts-I and II, Basic Electronics.

Course Objectives:

The objectives of this course are: To enable students to understand the basic principles of radiation detection, measurement techniques and instrumentation used for monitoring in nuclear systems.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the basic principles of radiation detection.

CO2: Describe the working of gas-filled detectors used in radiation measurement.

CO3: Describe the working of scintillation and semiconductor detectors.

CO4: Explain the basic principles of nuclear instrumentation used for reactor monitoring.

CO5: Explain the basic concepts of radiation dosimetry and health physics.

UNIT I: PRINCIPLES OF RADIATION DETECTION

Overview of interaction of radiation with matter, basic principles of radiation detection, basic concept of detector characteristics: efficiency, resolution and dead time, classification of radiation detectors.

UNIT II: GAS-FILLED DETECTORS

Gas-filled detectors: ionization chamber, proportional counter and Geiger-Muller counter - construction and

working, basic concept of pulse mode and current mode operation.

UNIT III: SCINTILLATION AND SEMICONDUCTOR DETECTORS

Scintillation detectors: organic and inorganic scintillators, basic concept of photomultiplier tubes, overview of semiconductor detectors: silicon and germanium detectors, basic concept of neutron detectors.

UNIT IV: NUCLEAR INSTRUMENTATION FOR REACTOR MONITORING

Overview of reactor instrumentation: source range, intermediate range and power range instrumentation, basic concept of signal processing and data acquisition, overview of reactor protection systems.

UNIT V: RADIATION DOSIMETRY AND HEALTH PHYSICS

Radiation dosimetry: concepts and units, overview of personal dosimeters: TLD, film badge and pocket dosimeter, area radiation monitoring instruments, basic principles of radiation protection.

TEXT BOOKS:

1. Glenn F. Knoll, Radiation Detection and Measurement, 4th Edition, Wiley, 2010.
2. Nicholas Tsoulfanidis, Measurement and Detection of Radiation, 4th Edition, CRC Press, 2015.
3. Herman Cember and Thomas E. Johnson, Introduction to Health Physics, 4th Edition, McGraw Hill, 2009.

REFERENCE BOOKS:

1. William J. Price, Nuclear Radiation Detection, 2nd Edition, McGraw Hill, 1964.
2. J. R. Lamarsh and A. J. Baratta, Introduction to Nuclear Engineering, 4th Edition, Pearson Education, 2017.
3. Gordon R. Gilmore, Practical Gamma-ray Spectrometry, 2nd Edition, Wiley, 2008.

Nuclear Security and Safeguards

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE04TH0607	Nuclear Security and Safeguards	MDM	03-00-00	50	50	03

Prerequisite: Nuclear Concepts-I and II, Basics of Nuclear Measurements.

Course Objectives:

The objectives of this course are: To enable students to understand the principles of nuclear security, safeguards, non-proliferation and the regulatory framework governing nuclear materials and facilities.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the concepts and importance of nuclear security and safeguards.

CO2: Describe the physical protection systems used for nuclear materials and facilities.

CO3: Explain the principles of nuclear material accounting and control.

CO4: Describe the international non-proliferation regime and safeguards agreements.

CO5: Explain the regulatory framework and emergency preparedness for nuclear security in India.

UNIT I: INTRODUCTION TO NUCLEAR SECURITY

Concept and objectives of nuclear security, difference between nuclear safety, security and safeguards, threats to nuclear materials and facilities, overview of the design basis threat concept.

UNIT II: PHYSICAL PROTECTION SYSTEMS

Elements of physical protection systems: detection, delay and response, physical barriers and access control systems, overview of surveillance and alarm systems, physical protection of nuclear facilities.

UNIT III: NUCLEAR MATERIAL ACCOUNTING AND CONTROL

Concept of material balance area, nuclear material accounting principles, basic concept of inventory verification methods, containment and surveillance measures, overview of material control and accounting systems.

UNIT IV: NON-PROLIFERATION AND SAFEGUARDS AGREEMENTS

Overview of the Nuclear Non-Proliferation Treaty (NPT), role of the International Atomic Energy Agency (IAEA), basic concept of safeguards agreements and the additional protocol, overview of export control regimes.

UNIT V: REGULATORY FRAMEWORK AND EMERGENCY PREPAREDNESS

Role of the Atomic Energy Regulatory Board (AERB) in India, regulatory framework for nuclear security, basic concept of radiological emergency preparedness and response, overview of transport security of nuclear and radioactive materials.

TEXT BOOKS:

1. J. R. Lamarsh and A. J. Baratta, Introduction to Nuclear Engineering, 4th Edition, Pearson Education, 2017.
2. International Atomic Energy Agency, Objective and Essential Elements of a State's Nuclear Security Regime, IAEA Nuclear Security Series, IAEA, Vienna.
3. Anthony V. Nero Jr., A Guidebook to Nuclear Reactors, University of California Press, 1979.

REFERENCE BOOKS:

1. International Atomic Energy Agency, Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities, IAEA Nuclear Security Series No. 13, IAEA, Vienna.
2. Charles D. Ferguson and William C. Potter, The Four Faces of Nuclear Terrorism, Routledge, 2005.
3. Atomic Energy Regulatory Board (AERB), Regulatory Guides and Codes on Nuclear and Radiation Safety, Government of India.

Multi-Disciplinary Minor (MDM): Robotics (Offered by RAI to B.Tech. ME)

Detailed Syllabus

Session: 2026-27

Fundamentals of Robotics

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26ES03TH0307-2	Fundamentals of Robotics	MDM	03-00-00	50	50	03

Prerequisite: Basic Mechanical/Electrical Engineering, Basics of Programming.

Course Objectives:

1: To introduce the fundamental concepts, history and classification of robots.

2: To develop understanding of robot anatomy and mechanical components.

3: To familiarize students with sensors and actuators used in robotic systems.

4: To develop basic understanding of robot control and programming.

5: To provide exposure to applications of robotics in various industries.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts, history and classification of robots.

CO2: Describe the anatomy and mechanical components of a robot.

CO3: Explain the working of sensors and actuators used in robotic systems.

CO4: Describe the basic principles of robot control and programming.

CO5: Discuss applications of robotics in industrial and non-industrial domains.

UNIT I: INTRODUCTION TO ROBOTICS (

Definition and history of robotics, laws of robotics, classification of robots, basic concept of robot generations, advantages and limitations of robots.

UNIT II: ROBOT ANATOMY AND MECHANICAL COMPONENTS (

Robot anatomy: links and joints, basic concept of degrees of freedom, overview of robot configurations: Cartesian, cylindrical, spherical and articulated, basic concept of end effectors and grippers.

UNIT III: SENSORS AND ACTUATORS IN ROBOTICS (

Overview of classification of sensors used in robots: position, proximity and force sensors, basic concept of actuators: pneumatic, hydraulic and electric, sensor and actuator selection criteria.

UNIT IV: ROBOT CONTROL AND PROGRAMMING (

Basic concept of robot control systems, overview of robot programming methods: teach pendant and offline programming, introduction to robot programming languages, basic concept of robot work cell design.

UNIT V: APPLICATIONS OF ROBOTICS (

Overview of industrial applications: material handling, welding and assembly, basic concept of applications in healthcare, agriculture and service sectors, emerging trends in robotics.

TEXT BOOKS:

1. S. K. Saha, Introduction to Robotics, 2nd Edition, McGraw Hill Education, 2014.
2. R. K. Mittal and I. J. Nagrath, Robotics and Control, McGraw Hill Education, 2003.
3. Saeed B. Niku, Introduction to Robotics: Analysis, Control, Applications, 3rd Edition, Wiley, 2020.

REFERENCE BOOKS:

1. John J. Craig, Introduction to Robotics: Mechanics and Control, 3rd Edition, Pearson Education, 2005.
2. Mikell P. Groover et al., Industrial Robotics: Technology, Programming, and Applications, McGraw Hill Education, 2012.
3. K. S. Fu, R. C. Gonzalez and C. S. G. Lee, Robotics: Control, Sensing, Vision, and Intelligence, McGraw Hill Education, 1987.

Kinematics of Robots

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26ES03TH0407-2	Kinematics of Robots	MDM	03-00-00	50	50	03

Prerequisite: Fundamentals of Robotics, Engineering Mathematics.

Course Objectives:

1: To introduce the mathematical foundations required for robot kinematics.

2: To develop understanding of forward kinematics of robot manipulators.

3: To develop understanding of inverse kinematics of robot manipulators.

4: To familiarize students with robot workspace and trajectory planning.

5: To provide basic understanding of robot dynamics and Jacobian analysis.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Apply mathematical foundations (coordinate transformations, matrices) for robot kinematics.

CO2: Formulate forward kinematics equations for robot manipulators using Denavit-Hartenberg (D-H) parameters.

CO3: Solve inverse kinematics problems for robot manipulators.

CO4: Analyze robot workspace and plan trajectories for robot motion.

CO5: Explain the basic concepts of robot dynamics and Jacobian analysis.

UNIT I: MATHEMATICAL FOUNDATIONS FOR ROBOT KINEMATICS (

Coordinate systems and transformations, homogeneous transformation matrices, basic concept of rotation matrices, representation of position and orientation.

UNIT II: FORWARD KINEMATICS (

Denavit-Hartenberg (D-H) representation, basic concept of forward kinematics of 2-link and 3-link manipulators, overview of forward kinematics of standard robot configurations.

UNIT III: INVERSE KINEMATICS (

Inverse kinematics problem formulation, basic concept of analytical and geometric solution methods, multiple solutions and workspace considerations.

UNIT IV: ROBOT WORKSPACE AND TRAJECTORY PLANNING (

Robot workspace: definition and types, basic concept of joint space and cartesian space trajectory planning, overview of trajectory generation techniques.

UNIT V: ROBOT DYNAMICS AND JACOBIAN ANALYSIS (

Basic concept of the robot Jacobian and velocity analysis, overview of robot dynamics: Lagrangian formulation, basic concept of singularity.

TEXT BOOKS:

1. S. K. Saha, Introduction to Robotics, 2nd Edition, McGraw Hill Education, 2014.
2. John J. Craig, Introduction to Robotics: Mechanics and Control, 3rd Edition, Pearson Education, 2005.

3. Mark W. Spong, Seth Hutchinson and M. Vidyasagar, Robot Modeling and Control, 2nd Edition, Wiley, 2020.

REFERENCE BOOKS:

1. K. S. Fu, R. C. Gonzalez and C. S. G. Lee, Robotics: Control, Sensing, Vision, and Intelligence, McGraw Hill Education, 1987.
2. R. K. Mittal and I. J. Nagrath, Robotics and Control, McGraw Hill Education, 2003.
3. Reza N. Jazar, Theory of Applied Robotics: Kinematics, Dynamics, and Control, 2nd Edition, Springer, 2010.

Mobile Robotics

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26ES03TH0507-2	Mobile Robotics	MDM	03-00-00	50	50	03

Prerequisite: Fundamentals of Robotics, Kinematics of Robots.

Course Objectives:

1: To introduce the fundamental concepts and classification of mobile robots.
2: To develop understanding of locomotion mechanisms used in mobile robots.
3: To familiarize students with sensing and perception techniques for mobile robots.
4: To develop understanding of localization and mapping techniques for mobile robots.
5: To provide exposure to navigation and path planning for mobile robots.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts and classification of mobile robots.
CO2: Describe locomotion mechanisms used in wheeled, legged and tracked mobile robots.
CO3: Explain sensing and perception techniques used in mobile robots.
CO4: Describe localization and mapping techniques for mobile robots.
CO5: Apply navigation and path planning techniques for mobile robot operation.

UNIT I: INTRODUCTION TO MOBILE ROBOTICS (

Definition and classification of mobile robots, applications of mobile robots, basic concept of mobile robot architecture, challenges in mobile robotics.

UNIT II: LOCOMOTION MECHANISMS (

Basic concept of wheeled locomotion: types and kinematics, overview of legged locomotion, basic concept of tracked locomotion, locomotion mechanism selection criteria.

UNIT III: SENSING AND PERCEPTION (

Overview of sensors for mobile robots: proximity, vision and range sensors, basic concept of sensor fusion, basic concept of perception for obstacle detection.

UNIT IV: LOCALIZATION AND MAPPING (

Basic concept of robot localization, overview of mapping techniques, introduction to the basic concept of Simultaneous Localization and Mapping (SLAM).

UNIT V: NAVIGATION AND PATH PLANNING (

Basic concept of path planning algorithms, overview of obstacle avoidance techniques, basic concept of autonomous navigation, case studies of mobile robot applications.

TEXT BOOKS:

1. Roland Siegwart, Illah R. Nourbakhsh and Davide Scaramuzza, Introduction to Autonomous Mobile Robots, 2nd Edition, MIT Press, 2011.
2. Sebastian Thrun, Wolfram Burgard and Dieter Fox, Probabilistic Robotics, MIT Press, 2005.
3. Saeed B. Niku, Introduction to Robotics: Analysis, Control, Applications, 3rd Edition, Wiley, 2020.

REFERENCE BOOKS:

1. Gregory Dudek and Michael Jenkin, Computational Principles of Mobile Robotics, 2nd Edition, Cambridge University Press, 2010.
2. Robin R. Murphy, Introduction to AI Robotics, 2nd Edition, MIT Press, 2019.
3. Alonzo Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Press, 2013.

Drone Technology

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26ES03TH0607-2	Drone Technology	MDM	03-00-00	50	50	03

Prerequisite: Fundamentals of Robotics, Basic Electronics.

Course Objectives:

1: To introduce the fundamental concepts, classification and components of unmanned aerial vehicles (drones).
2: To develop understanding of the aerodynamics and flight principles of drones.
3: To familiarize students with drone propulsion, power systems and control systems.
4: To develop understanding of drone navigation, communication and payload systems.
5: To provide exposure to drone applications and the regulatory framework.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts, classification and components of unmanned aerial vehicles (drones).
CO2: Describe the aerodynamics and flight principles of drones.
CO3: Explain drone propulsion, power systems and flight control systems.
CO4: Describe drone navigation, communication and payload systems.
CO5: Discuss drone applications and the regulatory framework governing drone operations in India.

UNIT I: INTRODUCTION TO DRONE TECHNOLOGY (

Definition, history and classification of UAVs/drones, overview of drone components, basic concept of types of drones: fixed wing, rotary wing and hybrid.

UNIT II: AERODYNAMICS AND FLIGHT PRINCIPLES (

Basic principles of flight: lift, drag, thrust and weight, overview of aerodynamics of multirotor drones, basic concept of stability and control surfaces.

UNIT III: PROPULSION AND CONTROL SYSTEMS

Overview of drone propulsion systems: motors, propellers and batteries, basic concept of flight controllers, overview of sensors used in drones: IMU, GPS and barometer.

UNIT IV: NAVIGATION, COMMUNICATION AND PAYLOAD SYSTEMS

Basic concept of drone navigation systems, overview of communication systems and telemetry, basic concept of payload systems: cameras and sensors, basic concept of the ground control station.

UNIT V: DRONE APPLICATIONS AND REGULATIONS

Overview of applications of drones: agriculture, surveillance, delivery and mapping, basic concept of drone regulations in India (DGCA guidelines), safety considerations in drone operations, emerging trends in drone technology.

TEXT BOOKS:

1. Kimon P. Valavanis and George J. Vachtsevanos (Eds.), Handbook of Unmanned Aerial Vehicles, Springer, 2015.
2. John Baichtal, Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs, Que Publishing, 2015.
3. Terry Kilby and Belinda Kilby, Getting Started with Drone Programming, McGraw Hill Education, 2016.

REFERENCE BOOKS:

1. Reg Austin, Unmanned Aircraft Systems: UAVS Design, Development and Deployment, Wiley, 2010.
2. Directorate General of Civil Aviation (DGCA), Government of India, Drone Rules and Guidelines, latest edition.
3. Randal W. Beard and Timothy W. McLain, Small Unmanned Aircraft: Theory and Practice, Princeton University Press, 2012.

Multi-Disciplinary Minor (MDM): Embedded Systems and IoT (Offered by ECE dept. to B.Tech. ME)

Detailed Syllabus

Session: 2026-27

Sensors for IoT

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE05TH0306-1	Sensors for IoT	MDM	03-00-00	50	50	03

Prerequisite: Basic Electronics, Basics of Physics.

Course Objectives:

1: To introduce the fundamental concepts and classification of sensors used in IoT systems.

2: To develop understanding of physical and environmental sensors used in IoT.

3: To familiarize students with proximity, motion and position sensors.

4: To develop understanding of sensor signal conditioning and interfacing techniques.

5: To provide exposure to sensor selection criteria for IoT applications.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts, classification and characteristics of sensors used in IoT.

CO2: Describe the working principles of physical and environmental sensors (temperature, humidity, pressure) used in IoT.

CO3: Describe the working principles of proximity, motion and position sensors used in IoT.

CO4: Explain sensor signal conditioning and interfacing techniques for IoT applications.

CO5: Apply sensor selection criteria for designing IoT-based sensing systems.

UNIT I: INTRODUCTION TO SENSORS FOR IOT C

Definition and role of sensors in IoT systems, classification of sensors, basic concept of sensor characteristics: sensitivity, accuracy and response time, overview of IoT sensing architecture.

UNIT II: PHYSICAL AND ENVIRONMENTAL SENSORS C

Basic concept of temperature sensors: thermocouple, RTD and thermistor, overview of humidity sensors, basic concept of pressure sensors, overview of gas and air quality sensors.

UNIT III: PROXIMITY, MOTION AND POSITION SENSORS C

Basic concept of proximity sensors: capacitive, inductive and ultrasonic, overview of motion sensors: PIR, accelerometer and gyroscope, basic concept of position and location sensors: GPS.

UNIT IV: SENSOR SIGNAL CONDITIONING AND INTERFACING C

Basic concept of signal conditioning circuits, overview of amplification and filtering, basic concept of analog-to-digital conversion, overview of sensor interfacing with microcontrollers.

UNIT V: SENSOR SELECTION AND APPLICATIONS IN IOT C

Sensor selection criteria for IoT applications, basic concept of power consumption considerations, overview of wireless sensor nodes, case studies of sensor-based IoT applications.

TEXT BOOKS:

1. Jacob Fraden, Handbook of Modern Sensors: Physics, Designs, and Applications, 5th Edition, Springer, 2016.
2. Arshdeep Bahga and Vijay Madisetti, Internet of Things: A Hands-On Approach, Universities Press, 2015.
3. D. Patranabis, Sensors and Transducers, 2nd Edition, PHI Learning, 2003.

REFERENCE BOOKS:

1. Ramon Pallas-Areny and John G. Webster, Sensors and Signal Conditioning, 2nd Edition, Wiley, 2001.
2. Raj Kamal, Internet of Things: Architecture and Design Principles, 2nd Edition, McGraw Hill Education, 2020.
3. Nathan Ida, Sensors, Actuators, and Their Interfaces, 2nd Edition, SciTech Publishing, 2020.

Microcontrollers and IoT Applications

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE05TH0408-1	Microcontrollers and IoT Applications	MDM	03-00-00	50	50	03

Prerequisite: Sensors for IoT, Basics of Programming.

Course Objectives:

1: To introduce the architecture and features of microcontrollers used in IoT applications.

2: To develop understanding of microcontroller programming for IoT applications.

3: To familiarize students with GPIO, timers and interrupt handling in microcontrollers.

4: To develop understanding of communication interfaces (I2C, SPI, UART) in microcontrollers.

5: To enable students to design microcontroller-based IoT applications.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the architecture and features of microcontrollers used in IoT applications.

CO2: Develop programs for microcontrollers to perform basic IoT tasks.

CO3: Apply GPIO, timers and interrupt handling techniques in microcontroller-based applications.

CO4: Apply communication interfaces (I2C, SPI, UART) for microcontroller-based IoT applications.

CO5: Design and develop microcontroller-based IoT applications.

UNIT I: INTRODUCTION TO MICROCONTROLLERS (

Basic concept of microcontroller versus microprocessor, overview of the architecture of a typical microcontroller (8-bit/32-bit), overview of popular microcontroller families for IoT (ARM Cortex-M, ESP32).

UNIT II: MICROCONTROLLER PROGRAMMING (

Basic concept of the programming environment and toolchain, embedded C programming basics, basic concept of memory organization, overview of programming for IoT tasks.

UNIT III: GPIO, TIMERS AND INTERRUPTS (

General purpose input/output (GPIO) programming, basic concept of timer/counter modules, overview of interrupt handling, basic concept of PWM generation.

UNIT IV: COMMUNICATION INTERFACES (

Basic concept of serial communication: UART, overview of the I2C protocol, basic concept of the SPI protocol, interfacing sensors and peripherals using these protocols.

UNIT V: MICROCONTROLLER-BASED IOT APPLICATIONS (

Design of microcontroller-based IoT nodes, overview of integration of sensors and wireless modules, basic concept of power management in microcontroller-based IoT devices, case studies of IoT applications.

TEXT BOOKS:

1. Muhammad Ali Mazidi, Sarmad Naimi and Sepehr Naimi, The AVR Microcontroller and Embedded Systems, Pearson Education, 2011.
2. Marco Schwartz, Internet of Things with ESP8266, Packt Publishing, 2016.
3. Raj Kamal, Internet of Things: Architecture and Design Principles, 2nd Edition, McGraw Hill Education, 2020.

REFERENCE BOOKS:

1. Joseph Yiu, The Definitive Guide to ARM Cortex-M0/M0+ Processors, 2nd Edition, Newnes, 2015.

2. Simon Monk, Programming Arduino: Getting Started with Sketches, 2nd Edition, McGraw Hill Education, 2016.

3. Neil Kolban, Kolban's Book on ESP32, Leanpub, 2017.

IoT System Architecture

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE05TH0507-1	IoT System Architecture	MDM	03-00-00	50	50	03

Prerequisite: Microcontrollers and IoT Applications, Sensors for IoT.

Course Objectives:

1: To introduce the layered architecture and reference models of IoT systems.

2: To develop understanding of IoT communication protocols and networking technologies.

3: To familiarize students with IoT middleware and data management architecture.

4: To develop understanding of edge, fog and cloud computing in IoT architecture.

5: To provide exposure to IoT platform design and security architecture.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the layered architecture and reference models of IoT systems.

CO2: Describe IoT communication protocols and networking technologies used across the architecture.

CO3: Explain IoT middleware and data management architecture.

CO4: Describe the role of edge, fog and cloud computing in IoT system architecture.

CO5: Discuss IoT platform design principles and security architecture.

UNIT I: IOT ARCHITECTURE FUNDAMENTALS (

Overview of IoT reference architecture, basic concept of layered IoT architecture: perception, network, middleware and application layers, IoT architecture design considerations.

UNIT II: IOT COMMUNICATION AND NETWORKING (

Overview of IoT communication protocols: MQTT, CoAP and HTTP, basic concept of network layer protocols: 6LoWPAN and RPL, overview of IoT networking topologies.

UNIT III: IOT MIDDLEWARE AND DATA MANAGEMENT (

Basic concept of the role of middleware in IoT architecture, data management architecture for IoT, basic concept of message brokers and data buses, overview of API management for IoT.

UNIT IV: EDGE, FOG AND CLOUD COMPUTING IN IOT (

Basic concept of edge computing in IoT architecture, overview of fog computing, cloud computing integration in IoT architecture, comparison of edge, fog and cloud computing approaches.

UNIT V: IOT PLATFORM DESIGN AND SECURITY ARCHITECTURE (

Overview of popular IoT platforms and their architecture, basic concept of IoT platform design principles, basic

concept of security architecture for IoT systems, case studies of IoT system architectures.

TEXT BOOKS:

1. Raj Kamal, Internet of Things: Architecture and Design Principles, 2nd Edition, McGraw Hill Education, 2020.
2. Arshdeep Bahga and Vijay Madisetti, Internet of Things: A Hands-On Approach, Universities Press, 2015.
3. Pethuru Raj and Anupama C. Raman, The Internet of Things: Enabling Technologies, Platforms, and Use Cases, CRC Press, 2017.

REFERENCE BOOKS:

1. Jan Holler et al., From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Academic Press, 2014.
2. Rajkumar Buyya and Amir Vahid Dastjerdi (Eds.), Internet of Things: Principles and Paradigms, Morgan Kaufmann, 2016.
3. Adrian McEwen and Hakim Cassimally, Designing the Internet of Things, Wiley, 2013.

Use Cases of IoT

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE05TH0608-1	Use Cases of IoT	MDM	03-00-00	50	50	03

Prerequisite: IoT System Architecture, Microcontrollers and IoT Applications.

Course Objectives:

1: To introduce IoT applications and use cases in smart homes and smart cities.
2: To develop understanding of IoT applications in healthcare and agriculture.
3: To familiarize students with IoT applications in industrial and manufacturing sectors.
4: To develop understanding of IoT applications in transportation and logistics.
5: To provide exposure to emerging IoT use cases and case study analysis.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain IoT use cases and applications in smart homes and smart cities.
CO2: Describe IoT applications in healthcare and precision agriculture.
CO3: Explain IoT applications in industrial automation and manufacturing (IIoT).
CO4: Describe IoT applications in transportation, logistics and smart mobility.
CO5: Analyze emerging IoT use cases and evaluate real-world IoT case studies.

UNIT I: IOT IN SMART HOMES AND SMART CITIES

Basic concept of smart home applications: home automation and energy management, overview of smart city components, case studies of smart home and smart city IoT deployments.

UNIT II: IOT IN HEALTHCARE AND AGRICULTURE

Basic concept of IoT applications in healthcare: remote patient monitoring and wearable devices, overview of IoT

applications in precision agriculture: soil monitoring and smart irrigation.

UNIT III: IOT IN INDUSTRY (IIOT) (

Basic concept of industrial IoT applications: predictive maintenance and asset tracking, overview of IoT in manufacturing: process monitoring and control, case studies of industrial IoT deployments.

UNIT IV: IOT IN TRANSPORTATION AND LOGISTICS (

Basic concept of IoT applications in transportation: vehicle tracking and fleet management, overview of smart mobility and connected vehicles, basic concept of IoT in logistics and supply chain management.

UNIT V: EMERGING IOT USE CASES AND CASE STUDIES (

Overview of emerging IoT applications: environmental monitoring, smart retail and smart energy grids, comparative analysis of IoT use cases, presentation and discussion of real-world IoT case studies.

TEXT BOOKS:

1. Arshdeep Bahga and Vijay Madisetti, Internet of Things: A Hands-On Approach, Universities Press, 2015.
2. Rajkumar Buyya and Amir Vahid Dastjerdi (Eds.), Internet of Things: Principles and Paradigms, Morgan Kaufmann, 2016.
3. Peter Waher, Learning Internet of Things, Packt Publishing, 2015.

REFERENCE BOOKS:

1. Vijay Madisetti and Arshdeep Bahga, Internet of Things: A Hands-On Approach, 2nd Edition, VPT Publishing, 2018.
2. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016.
3. Olivier Hersent, David Boswarthick and Omar Elloumi, The Internet of Things: Key Applications and Protocols, 2nd Edition, Wiley, 2012.

Multi-Disciplinary Minor (MDM): Mobile Communication (Offered by ECE dept. to B.Tech. ME)

Detailed Syllabus

Session: 2026-27

Fundamentals of Communication

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE05TH0306-2	Fundamentals of Communication	MDM	03-00-00	50	50	03

Prerequisite: Basic Electronics, Engineering Mathematics.

Course Objectives:

1: To introduce the fundamental concepts and building blocks of communication systems.

2: To develop understanding of analog and digital modulation techniques.

3: To familiarize students with multiplexing and multiple access techniques.

4: To develop understanding of transmission media and channel characteristics.

5: To provide exposure to noise and performance analysis of communication systems.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts and building blocks of a communication system.

CO2: Analyze analog and digital modulation techniques for signal transmission.

CO3: Explain multiplexing and multiple access techniques used in communication systems.

CO4: Describe transmission media and channel characteristics relevant to communication systems.

CO5: Analyze the effect of noise on communication system performance.

UNIT I: INTRODUCTION TO COMMUNICATION SYSTEMS C

Elements of a communication system, classification of signals, need for modulation, basic concept of baseband and passband transmission.

UNIT II: MODULATION TECHNIQUES C

Basic concept of analog modulation: AM, FM and PM, overview of digital modulation: ASK, FSK, PSK and QAM, comparison of modulation techniques.

UNIT III: MULTIPLEXING AND MULTIPLE ACCESS TECHNIQUES C

Basic concept of multiplexing techniques: FDM and TDM, overview of multiple access techniques: FDMA, TDMA and CDMA, basic concept of OFDM.

UNIT IV: TRANSMISSION MEDIA AND CHANNEL CHARACTERISTICS C

Overview of wired media: twisted pair, coaxial cable and optical fiber, basic concept of wireless channel characteristics: path loss, fading and multipath, basic concept of channel capacity.

UNIT V: NOISE AND PERFORMANCE ANALYSIS C

Sources and types of noise in communication systems, basic concept of signal-to-noise ratio, basic concept of bit error rate, performance evaluation of communication systems.

TEXT BOOKS:

1. Simon Haykin, Communication Systems, 5th Edition, Wiley, 2009.

2. B. P. Lathi and Zhi Ding, Modern Digital and Analog Communication Systems, 4th Edition, Oxford University Press, 2010.

3. John G. Proakis and Masoud Salehi, Communication Systems Engineering, 2nd Edition, Pearson Education, 2002.

REFERENCE BOOKS:

1. Herbert Taub, Donald L. Schilling and Goutam Saha, Principles of Communication Systems, 3rd Edition, McGraw Hill Education, 2013.

2. Wayne Tomasi, Electronic Communications Systems, 5th Edition, Pearson Education, 2013.

3. A. Bruce Carlson and Paul B. Crilly, Communication Systems, 5th Edition, McGraw Hill Education, 2010.

Cellular Communication

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE05TH0408-2	Cellular Communication	MDM	03-00-00	50	50	03

Prerequisite: Fundamentals of Communication.

Course Objectives:

1: To introduce the fundamental concepts and architecture of cellular communication systems.

2: To develop understanding of cellular concepts: frequency reuse, cell splitting and handoff.

3: To familiarize students with 1G and 2G cellular communication technologies.

4: To develop understanding of 3G cellular communication technologies.

5: To provide exposure to cellular network planning and capacity considerations.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts and architecture of cellular communication systems.

CO2: Apply cellular concepts: frequency reuse, cell splitting and handoff for network design.

CO3: Describe 1G and 2G cellular communication technologies and standards.

CO4: Describe 3G cellular communication technologies and standards.

CO5: Apply cellular network planning and capacity estimation techniques.

UNIT I: INTRODUCTION TO CELLULAR COMMUNICATION (

Evolution of cellular systems, cellular system architecture, basic concept of cell structure, overview of mobile station and base station.

UNIT II: CELLULAR CONCEPTS (

Basic concept of frequency reuse, channel assignment strategies, basic concept of cell splitting and sectoring, overview of handoff strategies.

UNIT III: 1G AND 2G TECHNOLOGIES (

Basic concept of 1G analog cellular systems, overview of 2G digital cellular systems: GSM architecture, basic concept of GSM channels and services.

UNIT IV: 3G TECHNOLOGIES (

Basic concept of 3G network architecture, overview of UMTS/WCDMA, 3G services and applications, basic concept of the evolution from 2G to 3G.

UNIT V: CELLULAR NETWORK PLANNING (

Basic concept of cellular network planning, basic concept of capacity estimation, overview of interference management, case studies of cellular network deployment.

TEXT BOOKS:

1. Theodore S. Rappaport, Wireless Communications: Principles and Practice, 2nd Edition, Pearson Education, 2002.

2. William C. Y. Lee, Mobile Cellular Telecommunications, 2nd Edition, McGraw Hill Education, 1995.

3. Jochen Schiller, Mobile Communications, 2nd Edition, Pearson Education, 2003.

REFERENCE BOOKS:

1. Vijay K. Garg, Wireless Communications and Networking, Morgan Kaufmann, 2007.
2. Gordon L. Stuber, Principles of Mobile Communication, 3rd Edition, Springer, 2011.
3. Kaveh Pahlavan and Prashant Krishnamurthy, Principles of Wireless Networks, Pearson Education, 2002.

LTE Technologies

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE05TH0507-2	LTE Technologies	MDM	03-00-00	50	50	03

Prerequisite: Cellular Communication.

Course Objectives:

1: To introduce the fundamental concepts and architecture of LTE networks.
2: To develop understanding of LTE radio interface and physical layer technologies.
3: To familiarize students with LTE network protocols and procedures.
4: To develop understanding of LTE-Advanced technologies and enhancements.
5: To provide exposure to LTE network planning and quality of service considerations.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts and architecture of LTE networks.
CO2: Describe the LTE radio interface and physical layer technologies (OFDMA, SC-FDMA, MIMO).
CO3: Explain LTE network protocols and procedures (attach, handover).
CO4: Describe LTE-Advanced technologies and enhancements.
CO5: Apply LTE network planning and quality of service (QoS) considerations.

UNIT I: INTRODUCTION TO LTE (

Evolution from 3G to LTE, basic concept of LTE network architecture: E-UTRAN and EPC, overview of LTE requirements and objectives.

UNIT II: LTE RADIO INTERFACE (

Basic concept of OFDMA and SC-FDMA, overview of the LTE frame structure, basic concept of MIMO technology in LTE, overview of LTE physical channels.

UNIT III: LTE PROTOCOLS AND PROCEDURES (

Basic concept of the LTE protocol stack, overview of attach and detach procedures, basic concept of handover procedures in LTE, overview of mobility management.

UNIT IV: LTE-ADVANCED TECHNOLOGIES (

Basic concept of carrier aggregation, overview of enhanced MIMO techniques, basic concept of coordinated multipoint (CoMP), basic concept of relay nodes.

UNIT V: LTE NETWORK PLANNING AND QOS (

Basic concept of LTE network planning, basic concept of quality of service (QoS) architecture in LTE, overview of VoLTE, case studies of LTE network deployment.

TEXT BOOKS:

1. Erik Dahlman, Stefan Parkvall and Johan Skold, 4G: LTE/LTE-Advanced for Mobile Broadband, 2nd Edition, Academic Press, 2013.
2. Farooq Khan, LTE for 4G Mobile Broadband, Cambridge University Press, 2009.
3. Martin Sauter, From GSM to LTE-Advanced Pro and 5G, 4th Edition, Wiley, 2021.

REFERENCE BOOKS:

1. Harri Holma and Antti Toskala (Eds.), LTE for UMTS: Evolution to LTE-Advanced, 2nd Edition, Wiley, 2011.
2. Stefania Sesia, Issam Toufik and Matthew Baker, LTE - The UMTS Long Term Evolution, 2nd Edition, Wiley, 2011.
3. Chris Johnson, Long Term Evolution in Bullets, 2nd Edition, CreateSpace, 2012.

5G and 6G Systems

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE05TH0608-2	5G and 6G Systems	MDM	03-00-00	50	50	03

Prerequisite: LTE Technologies.

Course Objectives:

1: To introduce the fundamental concepts, requirements and architecture of 5G networks.
2: To develop understanding of key enabling technologies for 5G systems.
3: To familiarize students with 5G use cases and network slicing concepts.
4: To develop understanding of the vision, requirements and emerging technologies for 6G networks.
5: To provide exposure to future trends and applications of beyond-5G/6G communication systems.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts, requirements and architecture of 5G networks.
CO2: Describe key enabling technologies for 5G systems (massive MIMO, mmWave, beamforming).
CO3: Explain 5G use cases (eMBB, URLLC, mMTC) and network slicing concepts.
CO4: Describe the vision, requirements and emerging technologies for 6G networks.
CO5: Discuss future trends and applications of beyond-5G/6G communication systems.

UNIT I: INTRODUCTION TO 5G NETWORKS

Evolution from 4G to 5G, overview of 5G requirements and objectives, basic concept of 5G network architecture.

UNIT II: 5G ENABLING TECHNOLOGIES

Basic concept of massive MIMO, overview of millimeter wave (mmWave) communication, basic concept of beamforming, overview of small cells and heterogeneous networks.

UNIT III: 5G USE CASES AND NETWORK SLICING

Basic concept of 5G use cases: eMBB, URLLC and mMTC, basic concept of network slicing, overview of software-

defined networking (SDN) and network function virtualization (NFV) in 5G.

UNIT IV: INTRODUCTION TO 6G NETWORKS

Overview of the vision and requirements of 6G networks, basic concept of key performance indicators for 6G, basic concept of emerging technologies for 6G: terahertz communication and AI-native networks.

UNIT V: FUTURE TRENDS IN BEYOND-5G/6G COMMUNICATION

Overview of integration of AI/ML with future networks, basic concept of satellite and non-terrestrial networks, overview of applications of 6G: holographic communication and extended reality, case studies of future communication systems.

TEXT BOOKS:

1. Afif Osseiran, Jose F. Monserrat and Patrick Marsch (Eds.), 5G Mobile and Wireless Communications Technology, Cambridge University Press, 2016.
2. Erik Dahlman, Stefan Parkvall and Johan Skold, 5G NR: The Next Generation Wireless Access Technology, 2nd Edition, Academic Press, 2020.
3. Ian F. Akyildiz et al., 6G and Beyond: The Future of Wireless Communications Systems, IEEE Press, 2021.

REFERENCE BOOKS:

1. Martin Sauter, From GSM to LTE-Advanced Pro and 5G, 4th Edition, Wiley, 2021.
2. Jonathan Rodriguez (Ed.), Fundamentals of 5G Mobile Networks, Wiley, 2015.
3. Wei Xiang, Kan Zheng and Xuemin Shen (Eds.), 5G Mobile Communications, Springer, 2017.

Multi-Disciplinary Minor (MDM): IoT for Environmental Sustainability (Offered by ECS to B.Tech. ME)

Detailed Syllabus

Session: 2026-27

Introduction to IoT System Design

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE01TH0305-1	Introduction to IoT System Design	MDM	03-00-00	50	50	03

Prerequisite: Basic Electronics, Basics of Programming.

Course Objectives:

1: To introduce the fundamental concepts and architecture of IoT systems.

2: To develop understanding of IoT system design methodology.

3: To familiarize students with sensors, actuators and communication modules used in IoT system design.

4: To develop understanding of hardware and software components of an IoT system.

5: To provide exposure to designing a basic end-to-end IoT system.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts and architecture of IoT systems.

CO2: Describe the IoT system design methodology and design considerations.

CO3: Select appropriate sensors, actuators and communication modules for IoT system design.

CO4: Describe the hardware and software components required for IoT system design.

CO5: Design a basic end-to-end IoT system for a given application.

UNIT I: INTRODUCTION TO IOT SYSTEMS

Definition and characteristics of IoT, basic concept of IoT architecture: layers and components, overview of IoT system design considerations, applications of IoT in environmental sustainability.

UNIT II: IOT SYSTEM DESIGN METHODOLOGY

Basic concept of IoT design methodology: requirement analysis, system design and implementation, overview of design constraints for IoT systems, basic concept of IoT design tools.

UNIT III: SENSORS, ACTUATORS AND COMMUNICATION MODULES

Overview of sensors and actuators used in IoT system design, basic concept of communication modules: Wi-Fi, Bluetooth and Zigbee, overview of module selection criteria.

UNIT IV: HARDWARE AND SOFTWARE COMPONENTS OF IOT SYSTEMS

Overview of IoT hardware platforms: microcontrollers and development boards, basic concept of IoT software components: firmware and middleware, basic concept of IoT operating systems.

UNIT V: DESIGNING AN END-TO-END IOT SYSTEM

Basic concept of designing a basic end-to-end IoT system, integration of hardware and software components, overview of testing and validation of IoT system design, case studies of IoT system design.

TEXT BOOKS:

1. Arshdeep Bahga and Vijay Madisetti, Internet of Things: A Hands-On Approach, Universities Press, 2015.
2. Raj Kamal, Internet of Things: Architecture and Design Principles, 2nd Edition, McGraw Hill Education, 2020.
3. Adrian McEwen and Hakim Cassimally, Designing the Internet of Things, Wiley, 2013.

REFERENCE BOOKS:

1. Peter Waher, Learning Internet of Things, Packt Publishing, 2015.
2. Jan Holler et al., From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Academic Press, 2014.
3. Pethuru Raj and Anupama C. Raman, The Internet of Things: Enabling Technologies, Platforms, and Use Cases, CRC Press, 2017.

Programming for Environmental IoT

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE01TH0405-1	Programming for Environmental IoT	MDM	03-00-00	50	50	03

Prerequisite: Introduction to IoT System Design, Basics of Programming.

Course Objectives:

1: To introduce programming concepts for IoT devices used in environmental monitoring.

2: To develop skills in programming microcontrollers for sensor data acquisition.

3: To familiarize students with programming for wireless data transmission in environmental IoT.

4: To develop understanding of cloud-based data logging and processing for environmental IoT.

5: To enable students to develop simple environmental IoT monitoring applications.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain programming concepts and tools used for IoT devices in environmental monitoring.

CO2: Program microcontrollers for acquiring data from environmental sensors.

CO3: Implement wireless data transmission programs for environmental IoT applications.

CO4: Develop programs for cloud-based data logging and processing of environmental data.

CO5: Develop simple environmental IoT monitoring applications.

UNIT I: PROGRAMMING FUNDAMENTALS FOR ENVIRONMENTAL IOT

Overview of programming languages for IoT (Python, Embedded C), basic concept of IoT programming environments, overview of programming for environmental monitoring applications.

UNIT II: SENSOR DATA ACQUISITION PROGRAMMING

Basic concept of programming for reading environmental sensor data (temperature, humidity, air quality), overview of data preprocessing at the device level, basic concept of sensor calibration in code.

UNIT III: WIRELESS DATA TRANSMISSION PROGRAMMING

Basic concept of programming for Wi-Fi/Bluetooth-based data transmission, overview of MQTT/HTTP protocol programming, basic concept of error handling in wireless communication.

UNIT IV: CLOUD-BASED DATA LOGGING AND PROCESSING

Basic concept of programming for cloud data logging platforms, basic concept of data processing and storage in the cloud, overview of dashboard integration for environmental data.

UNIT V: ENVIRONMENTAL IOT APPLICATION DEVELOPMENT

Basic concept of design and development of a simple environmental monitoring application, integration of sensing, transmission and cloud logging, overview of testing and debugging, case studies of environmental IoT applications.

TEXT BOOKS:

1. Marco Schwartz, Internet of Things with ESP8266, Packt Publishing, 2016.
2. Arshdeep Bahga and Vijay Madisetti, Internet of Things: A Hands-On Approach, Universities Press, 2015.
3. Simon Monk, Programming Arduino: Getting Started with Sketches, 2nd Edition, McGraw Hill Education, 2016.

REFERENCE BOOKS:

1. Massimo Banzi and Michael Shiloh, Getting Started with Arduino, 3rd Edition, Maker Media, 2014.
2. Neil Kolban, Kolban's Book on ESP8266, Leanpub, 2016.
3. Peter Waher, Learning Internet of Things, Packt Publishing, 2015.

IoT Privacy and Security

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE01TH0505-1	IoT Privacy and Security	MDM	03-00-00	50	50	03

Prerequisite: Programming for Environmental IoT.

Course Objectives:

1: To introduce the fundamental concepts of privacy and security in IoT systems.

2: To develop understanding of security threats and vulnerabilities in IoT systems.

3: To familiarize students with cryptographic techniques used for IoT security.

4: To develop understanding of authentication and access control mechanisms for IoT.

5: To provide exposure to privacy-preserving techniques and security standards for IoT.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts of privacy and security in IoT systems.

CO2: Identify security threats and vulnerabilities in IoT systems.

CO3: Apply cryptographic techniques for securing IoT communication and data.

CO4: Describe authentication and access control mechanisms for IoT systems.

CO5: Discuss privacy-preserving techniques and security standards applicable to IoT.

UNIT I: INTRODUCTION TO IOT PRIVACY AND SECURITY (

Need for security and privacy in IoT, basic concept of IoT security architecture, overview of security requirements: confidentiality, integrity and availability.

UNIT II: SECURITY THREATS AND VULNERABILITIES (

Basic concept of classification of IoT security threats, overview of common vulnerabilities in IoT devices and networks, case studies of IoT security breaches.

UNIT III: CRYPTOGRAPHIC TECHNIQUES FOR IOT (

Basic concept of symmetric and asymmetric cryptography, overview of lightweight cryptography for IoT devices, basic concept of hashing and digital signatures.

UNIT IV: AUTHENTICATION AND ACCESS CONTROL (

Basic concept of authentication mechanisms for IoT devices, overview of access control models, basic concept of secure device provisioning.

UNIT V: PRIVACY-PRESERVING TECHNIQUES AND STANDARDS (

Basic concept of privacy-preserving techniques for IoT data, overview of IoT security standards and regulatory frameworks, data protection considerations for environmental IoT applications.

TEXT BOOKS:

1. Fei Hu, Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations, CRC

Press, 2016.

2. Raj Kamal, Internet of Things: Architecture and Design Principles, 2nd Edition, McGraw Hill Education, 2020.

3. William Stallings, Cryptography and Network Security: Principles and Practice, 7th Edition, Pearson Education, 2017.

REFERENCE BOOKS:

1. Vijay Madisetti and Arshdeep Bahga, Internet of Things: A Hands-On Approach, 2nd Edition, VPT Publishing, 2018.

2. IoT Security Foundation, IoT Security Compliance Framework, latest edition.

3. Bruce Schneier, Applied Cryptography: Protocols, Algorithms, and Source Code in C, 2nd Edition, Wiley, 1996.

Use Cases of Environmental IoT

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE01TH0605-1	Use Cases of Environmental IoT	MDM	03-00-00	50	50	03

Prerequisite: IoT Privacy and Security, Introduction to IoT System Design.

Course Objectives:

1: To introduce IoT applications and use cases for environmental monitoring.

2: To develop understanding of IoT applications for air and water quality monitoring.

3: To familiarize students with IoT applications in climate and weather monitoring.

4: To develop understanding of IoT applications for wildlife and forest conservation.

5: To provide exposure to emerging trends and case studies of environmental IoT deployments.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain IoT use cases and applications for environmental monitoring.

CO2: Describe IoT applications for air and water quality monitoring.

CO3: Explain IoT applications in climate and weather monitoring.

CO4: Describe IoT applications for wildlife and forest conservation.

CO5: Analyze emerging trends and evaluate real-world environmental IoT case studies.

UNIT I: IOT FOR ENVIRONMENTAL MONITORING - OVERVIEW (

Role of IoT in environmental sustainability, overview of environmental monitoring parameters, basic concept of IoT-based environmental monitoring system architecture.

UNIT II: IOT FOR AIR AND WATER QUALITY MONITORING (

Basic concept of IoT applications for air quality monitoring, overview of IoT applications for water quality monitoring, case studies of air/water quality IoT deployments.

UNIT III: IOT FOR CLIMATE AND WEATHER MONITORING (

Basic concept of IoT applications in weather monitoring stations, overview of IoT for climate data collection, basic

concept of integration with weather forecasting systems.

UNIT IV: IOT FOR WILDLIFE AND FOREST CONSERVATION

Basic concept of IoT applications in wildlife tracking and monitoring, overview of IoT for forest fire detection and prevention, basic concept of IoT in biodiversity conservation.

UNIT V: EMERGING TRENDS AND CASE STUDIES

Overview of emerging applications of environmental IoT: smart agriculture and waste management, basic concept of integration of AI with environmental IoT, presentation and discussion of real-world environmental IoT case studies.

TEXT BOOKS:

1. Arshdeep Bahga and Vijay Madisetti, Internet of Things: A Hands-On Approach, Universities Press, 2015.
2. Rajkumar Buyya and Amir Vahid Dastjerdi (Eds.), Internet of Things: Principles and Paradigms, Morgan Kaufmann, 2016.
3. Peter Waher, Learning Internet of Things, Packt Publishing, 2015.

REFERENCE BOOKS:

1. Nathan Ida, Sensors, Actuators, and Their Interfaces, 2nd Edition, SciTech Publishing, 2020.
2. Vijay Madisetti and Arshdeep Bahga, Internet of Things: A Hands-On Approach, 2nd Edition, VPT Publishing, 2018.
3. Olivier Hersent, David Boswarthick and Omar Elloumi, The Internet of Things: Key Applications and Protocols, 2nd Edition, Wiley, 2012.

Multi-Disciplinary Minor (MDM): Integrated Circuit Design (IC design) (Offered by ECS to B.Tech. ME)

Detailed Syllabus

Session: 2026-27

Basics of Chip Design using Verilog HDL

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE01TH0305-2	Basics of Chip Design using Verilog HDL	MDM	03-00-00	50	50	03

Prerequisite: Basic Digital Electronics, Basics of Programming.

Course Objectives:

1: To introduce the fundamental concepts of digital chip design and design flow.
2: To develop understanding of Verilog HDL syntax and constructs.
3: To familiarize students with behavioral and structural modeling using Verilog.
4: To develop skills in designing combinational and sequential circuits using Verilog.
5: To provide exposure to simulation and synthesis of digital designs.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts of digital chip design and the ASIC/FPGA design flow.

CO2: Apply Verilog HDL syntax and constructs for digital circuit description.

CO3: Develop behavioral and structural models of digital circuits using Verilog.

CO4: Design combinational and sequential circuits using Verilog HDL.

CO5: Simulate and synthesize digital designs using Verilog HDL tools.

UNIT I: INTRODUCTION TO DIGITAL CHIP DESIGN (

Overview of the digital design flow, basic concept of the ASIC and FPGA design flow, introduction to hardware description languages (HDL), role of Verilog in chip design.

UNIT II: VERILOG HDL FUNDAMENTALS (

Basic concept of Verilog HDL syntax: modules, ports and data types, operators and expressions, overview of Verilog design constructs.

UNIT III: BEHAVIORAL AND STRUCTURAL MODELING (

Basic concept of behavioral modeling: always block and initial block, overview of structural modeling: gate-level and dataflow modeling, basic concept of procedural assignments.

UNIT IV: DESIGNING COMBINATIONAL AND SEQUENTIAL CIRCUITS (

Basic concept of design of combinational circuits: multiplexers, adders and decoders, overview of design of sequential circuits: flip-flops, counters and registers, basic concept of finite state machine design.

UNIT V: SIMULATION AND SYNTHESIS (

Basic concept of testbench design, overview of simulation of Verilog designs, introduction to logic synthesis, basic concept of synthesizable versus non-synthesizable code.

TEXT BOOKS:

1. Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, 2nd Edition, Pearson Education, 2003.
2. J. Bhasker, Verilog HDL Primer, 3rd Edition, Star Galaxy Publishing, 2005.
3. Michael D. Ciletti, Advanced Digital Design with the Verilog HDL, 2nd Edition, Pearson Education, 2010.

REFERENCE BOOKS:

1. Douglas Perry, VHDL and Verilog for FPGA and ASIC Design, McGraw Hill Education, 2002.
2. Ming-Bo Lin, Digital System Designs and Practices Using Verilog HDL and FPGAs, Wiley, 2008.
3. Charles H. Roth Jr., Lizy K. John and Byeong Kil Lee, Digital Systems Design Using Verilog, Cengage Learning, 2016.

MIPS Processor Design and Testing

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE01TH0405-2	MIPS Processor Design and Testing	MDM	03-00-00	50	50	03

Prerequisite: Basics of Chip Design using Verilog HDL, Computer Organization.

Course Objectives:

1: To introduce the fundamentals of processor architecture and instruction set design.

2: To develop understanding of MIPS instruction set architecture.

3: To familiarize students with single-cycle and multi-cycle MIPS processor design.

4: To develop understanding of pipelined MIPS processor design and hazards.

5: To provide hands-on exposure to design and testing of a MIPS processor using Verilog HDL.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamentals of processor architecture and instruction set design.

CO2: Describe the MIPS instruction set architecture and instruction formats.

CO3: Design a single-cycle and multi-cycle MIPS processor datapath and control unit.

CO4: Analyze pipelined MIPS processor design and identify pipeline hazards.

CO5: Design and test a MIPS processor using Verilog HDL.

UNIT I: PROCESSOR ARCHITECTURE FUNDAMENTALS (

Basic concept of computer organization, basic concept of instruction set architecture, overview of RISC versus CISC architecture, basic concept of processor performance metrics.

UNIT II: MIPS INSTRUCTION SET ARCHITECTURE (

Basic concept of MIPS instruction formats: R-type, I-type and J-type, overview of MIPS instruction categories, basic concept of addressing modes in MIPS.

UNIT III: SINGLE-CYCLE AND MULTI-CYCLE MIPS DESIGN (

Basic concept of single-cycle datapath design, overview of control unit design for a single-cycle processor, basic concept of multi-cycle MIPS processor design.

UNIT IV: PIPELINED MIPS PROCESSOR DESIGN (

Basic concept of pipelining, overview of pipeline stages in a MIPS processor, basic concept of pipeline hazards: structural, data and control hazards, overview of hazard resolution techniques.

UNIT V: DESIGN AND TESTING OF MIPS PROCESSOR (

Basic concept of Verilog implementation of MIPS processor modules, testbench design for processor verification, overview of functional testing of the MIPS processor, case study of a simple MIPS processor design.

TEXT BOOKS:

1. David A. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, RISC-V Edition, 6th Edition, Morgan Kaufmann, 2020.

2. Sarah L. Harris and David Money Harris, Digital Design and Computer Architecture, 2nd Edition, Morgan Kaufmann, 2012.

3. Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, 2nd Edition, Pearson Education, 2003.

REFERENCE BOOKS:

1. John L. Hennessy and David A. Patterson, Computer Architecture: A Quantitative Approach, 6th Edition, Morgan Kaufmann, 2017.

2. Behrooz Parhami, Computer Architecture: From Microprocessors to Supercomputers, Oxford University Press, 2005.

3. William Stallings, Computer Organization and Architecture, 10th Edition, Pearson Education, 2015.

Chip Verification using System Verilog

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE01TH0505-2	Chip Verification using System Verilog	MDM	03-00-00	50	50	03

Prerequisite: MIPS Processor Design and Testing, Basics of Chip Design using Verilog HDL.

Course Objectives:

1: To introduce the fundamentals of functional verification and its role in chip design.

2: To develop understanding of SystemVerilog language constructs for verification.

3: To familiarize students with testbench architecture and verification methodologies.

4: To develop understanding of assertion-based verification and functional coverage.

5: To provide exposure to constrained random verification techniques.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamentals of functional verification and its importance in the chip design flow.

CO2: Apply SystemVerilog language constructs for design verification.

CO3: Design a testbench architecture for functional verification of digital designs.

CO4: Apply assertion-based verification and functional coverage techniques.

CO5: Apply constrained random verification techniques for chip verification.

UNIT I: INTRODUCTION TO FUNCTIONAL VERIFICATION

Role of verification in the chip design flow, basic concept of verification challenges, overview of verification methodologies, introduction to SystemVerilog for verification.

UNIT II: SYSTEMVERILOG LANGUAGE CONSTRUCTS

Basic concept of SystemVerilog data types, overview of classes and object-oriented programming concepts in SystemVerilog, basic concept of interfaces.

UNIT III: TESTBENCH ARCHITECTURE

Basic concept of testbench components: generator, driver, monitor and scoreboard, overview of layered testbench architecture, introduction to the basic concept of Universal Verification Methodology (UVM).

UNIT IV: ASSERTION-BASED VERIFICATION AND COVERAGE

Basic concept of SystemVerilog Assertions (SVA), overview of immediate and concurrent assertions, basic concept of functional coverage, overview of coverage-driven verification.

UNIT V: CONSTRAINED RANDOM VERIFICATION

Basic concept of constrained random test generation, overview of randomization in SystemVerilog, basic concept of verification planning, case studies of chip verification projects.

TEXT BOOKS:

1. Chris Spear and Greg Tumbush, SystemVerilog for Verification: A Guide to Learning the Testbench Language Features, 3rd Edition, Springer, 2012.

2. Janick Bergeron, Writing Testbenches using SystemVerilog, Springer, 2006.

3. Ben Cohen, Srinivasan Venkataramanan and Ajeetha Kumari, SystemVerilog Assertions Handbook, VhdlCohen Publishing, 2013.

REFERENCE BOOKS:

1. Sharon Rosenberg and Kathleen A. Meade, A Practical Guide to Adopting the Universal Verification Methodology (UVM), Cadence Design Systems, 2010.

2. Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, 2nd Edition, Pearson Education, 2003.

3. IEEE Std 1800, IEEE Standard for SystemVerilog, IEEE, latest edition.

VLSI Physical Design

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE01TH0605-2	VLSI Physical Design	MDM	03-00-00	50	50	03

Prerequisite: Chip Verification using System Verilog, Basics of Chip Design using Verilog HDL.

Course Objectives:

1: To introduce the fundamentals and stages of the VLSI physical design flow.

2: To develop understanding of floorplanning and power planning techniques.

3: To familiarize students with placement algorithms and techniques.

4: To develop understanding of clock tree synthesis and routing techniques.

5: To provide exposure to static timing analysis and physical design verification.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamentals and stages of the VLSI physical design flow.

CO2: Apply floorplanning and power planning techniques for chip design.

CO3: Explain placement algorithms and techniques used in physical design.

CO4: Describe clock tree synthesis and routing techniques used in physical design.

CO5: Apply static timing analysis and physical design verification techniques.

UNIT I: INTRODUCTION TO VLSI PHYSICAL DESIGN (

Overview of the VLSI design flow, basic concept of physical design flow stages, overview of design rules and constraints, basic concept of the standard cell library.

UNIT II: FLOORPLANNING AND POWER PLANNING (

Basic concept of floorplanning: objectives and techniques, overview of power planning: power grid design, basic concept of the power distribution network.

UNIT III: PLACEMENT

Basic concept of placement problem formulation, overview of placement algorithms: constructive and iterative techniques, basic concept of placement optimization.

UNIT IV: CLOCK TREE SYNTHESIS AND ROUTING

Basic concept of clock tree synthesis, overview of clock skew and clock latency, basic concept of routing: global and detailed routing, basic concept of routing congestion.

UNIT V: STATIC TIMING ANALYSIS AND VERIFICATION

Basic concept of static timing analysis (STA), overview of setup and hold time analysis, basic concept of physical verification: DRC and LVS, case studies of the physical design flow.

TEXT BOOKS:

1. Sung Kyu Lim, Practical Problems in VLSI Physical Design Automation, Springer, 2008.
2. Andrew B. Kahng, Jens Lienig, Igor L. Markov and Jin Hu, VLSI Physical Design: From Graph Partitioning to Timing Closure, Springer, 2011.
3. Naveed Sherwani, Algorithms for VLSI Physical Design Automation, 3rd Edition, Springer, 1999.

REFERENCE BOOKS:

1. Sadiq M. Sait and Habib Youssef, VLSI Physical Design Automation: Theory and Practice, World Scientific, 1999.
2. Himanshu Bhatnagar, Advanced ASIC Chip Synthesis, 2nd Edition, Springer, 2002.
3. Weste and Harris, CMOS VLSI Design: A Circuits and Systems Perspective, 4th Edition, Pearson Education, 2011.

Multi-Disciplinary Minor (MDM) offered by CSE: Web Development (Offered to B.Tech. ME)

Detailed Syllabus

Session: 2026-27

Introduction to Web Development

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26CS01TH0307	Introduction to Web Development	MDM	03-00-00	50	50	03

Prerequisite: Basic Computer Knowledge, Basics of Programming.

Course Objectives:

1: To introduce the fundamental concepts and evolution of web development.
2: To develop understanding of HTML for structuring web content.
3: To develop understanding of CSS for styling web pages.
4: To familiarize students with basic JavaScript for web page interactivity.
5: To provide exposure to responsive web design principles.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts and evolution of web development.

CO2: Design web page structure using HTML.

CO3: Apply CSS to style and layout web pages.

CO4: Apply basic JavaScript for adding interactivity to web pages.

CO5: Apply responsive web design principles to develop web pages for different devices.

UNIT I: INTRODUCTION TO WEB DEVELOPMENT

Evolution of the web, basic concept of client-server architecture, overview of web browsers and web servers, basic concept of front-end and back-end development.

UNIT II: HTML FUNDAMENTALS

HTML document structure, basic concept of HTML tags and elements, overview of forms and tables in HTML, basic concept of semantic HTML.

UNIT III: CSS FUNDAMENTALS

Basic concept of CSS syntax and selectors, overview of the box model, basic concept of CSS layout techniques: flexbox and grid, overview of CSS styling for text and backgrounds.

UNIT IV: BASIC JAVASCRIPT

Basic concept of JavaScript syntax and data types, overview of DOM manipulation, basic concept of event handling, basic form validation using JavaScript.

UNIT V: RESPONSIVE WEB DESIGN

Basic concept of responsive web design, overview of media queries, basic concept of the mobile-first design approach, introduction to CSS frameworks (overview of Bootstrap).

TEXT BOOKS:

1. Jon Duckett, HTML and CSS: Design and Build Websites, Wiley, 2011.
2. Jon Duckett, JavaScript and JQuery: Interactive Front-End Web Development, Wiley, 2014.
3. Robin Nixon, Learning PHP, MySQL & JavaScript with jQuery, CSS & HTML5, 5th Edition, O'Reilly Media, 2018.

REFERENCE BOOKS:

1. Elizabeth Castro and Bruce Hyslop, HTML5 and CSS3: Visual QuickStart Guide, 8th Edition, Peachpit Press, 2017.
2. David Flanagan, JavaScript: The Definitive Guide, 7th Edition, O'Reilly Media, 2020.
3. Ben Frain, Responsive Web Design with HTML5 and CSS, 3rd Edition, Packt Publishing, 2020.

Front End Development

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26CS01TH0407	Front End Development	MDM	03-00-00	50	50	03

Prerequisite: Introduction to Web Development.

Course Objectives:

1: To introduce advanced JavaScript concepts for front-end development.

2: To develop understanding of front-end frameworks and libraries.

3: To familiarize students with component-based web application development.

4: To develop understanding of state management in front-end applications.

5: To enable students to build interactive single-page web applications.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Apply advanced JavaScript concepts (ES6+ features) for front-end development.

CO2: Explain the fundamentals of front-end frameworks/libraries (overview of React/Angular/Vue).

CO3: Develop component-based web applications using a front-end framework.

CO4: Apply state management techniques in front-end applications.

CO5: Build interactive single-page web applications (SPAs) using a front-end framework.

UNIT I: ADVANCED JAVASCRIPT CONCEPTS (

Basic concept of ES6+ features: arrow functions, let/const and template literals, overview of promises and async/await, basic concept of modules in JavaScript.

UNIT II: INTRODUCTION TO FRONT-END FRAMEWORKS (

Overview of popular front-end frameworks/libraries (React, Angular, Vue), basic concept of component-based architecture, overview of setting up a front-end development environment.

UNIT III: COMPONENT-BASED APPLICATION DEVELOPMENT (

Basic concept of creating and using components, overview of props and component communication, basic concept of lifecycle methods/hooks.

UNIT IV: STATE MANAGEMENT (

Basic concept of application state, overview of local component state management, introduction to the basic concept of state management libraries (Redux/Context API).

UNIT V: SINGLE-PAGE APPLICATION DEVELOPMENT (

Basic concept of client-side routing, overview of API integration in front-end applications, building and deploying a simple SPA, basic concept of testing and debugging front-end applications.

TEXT BOOKS:

1. Alex Banks and Eve Porcello, Learning React: Modern Patterns for Developing React Apps, 2nd Edition, O'Reilly Media, 2020.
2. Robin Wieruch, The Road to React, Leanpub, 2021.
3. Jon Duckett, JavaScript and JQuery: Interactive Front-End Web Development, Wiley, 2014.

REFERENCE BOOKS:

1. Kirupa Chinnathambi, Learning React: A Hands-On Guide, 2nd Edition, Addison-Wesley, 2018.
2. Nate Murray et al., ng-book: The Complete Guide to Angular, Fullstack.io, 2019.
3. David Flanagan, JavaScript: The Definitive Guide, 7th Edition, O'Reilly Media, 2020.

Backend Technologies

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26CS01TH0507	Backend Technologies	MDM	03-00-00	50	50	03

Prerequisite: Front End Development, Basics of Programming.

Course Objectives:

1: To introduce the fundamentals of server-side/backend web development.

2: To develop understanding of building RESTful APIs.

3: To familiarize students with database integration for backend applications.

4: To develop understanding of authentication and session management in backend systems.

5: To enable students to develop and deploy a simple backend web application.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamentals of server-side/backend web development.

CO2: Design and develop RESTful APIs using a backend framework.

CO3: Integrate databases with backend web applications.

CO4: Implement authentication and session management in backend applications.

CO5: Develop and deploy a simple backend web application.

UNIT I: INTRODUCTION TO BACKEND DEVELOPMENT (

Basic concept of the client-server model, overview of backend technologies (Node.js/Python/PHP), basic concept of setting up a backend development environment.

UNIT II: BUILDING RESTFUL APIS (

Basic concept of REST architecture principles, overview of HTTP methods and status codes, basic concept of designing and implementing RESTful API endpoints.

UNIT III: DATABASE INTEGRATION (

Overview of relational (SQL) and non-relational (NoSQL) databases, basic concept of connecting backend applications to databases, overview of CRUD operations.

UNIT IV: AUTHENTICATION AND SESSION MANAGEMENT (

Basic concept of authentication mechanisms, overview of session management, basic concept of token-based authentication (JWT), basic security practices for backend applications.

UNIT V: BACKEND APPLICATION DEVELOPMENT AND DEPLOYMENT (

Basic concept of building a simple backend web application, overview of testing backend APIs, basic concept of deployment platforms and hosting, introduction to version control for backend projects.

TEXT BOOKS:

1. Mark Lutz, Learning Python, 5th Edition, O'Reilly Media, 2013.

2. Brad Dayley, Node.js, MongoDB and Angular Web Development, 2nd Edition, Addison-Wesley, 2017.

3. Robin Nixon, Learning PHP, MySQL & JavaScript with jQuery, CSS & HTML5, 5th Edition, O'Reilly Media, 2018.

REFERENCE BOOKS:

1. Miguel Grinberg, Flask Web Development, 2nd Edition, O'Reilly Media, 2018.
2. Ethan Brown, Web Development with Node and Express, 2nd Edition, O'Reilly Media, 2019.
3. Kyle Simpson, You Don't Know JS Yet: Get Started, Independently Published, 2020.

Cloud Technologies

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26CS01TH0607	Cloud Technologies	MDM	03-00-00	50	50	03

Prerequisite: Backend Technologies.

Course Objectives:

1: To introduce the fundamentals of cloud computing and its service models.

2: To develop understanding of deploying web applications on cloud platforms.

3: To familiarize students with cloud storage and database services.

4: To develop understanding of containerization and orchestration for web applications.

5: To provide exposure to cloud security and scalability considerations for web applications.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamentals of cloud computing and its service models (IaaS, PaaS, SaaS).

CO2: Deploy web applications on popular cloud platforms.

CO3: Utilize cloud storage and database services for web applications.

CO4: Apply containerization and orchestration concepts for web application deployment.

CO5: Discuss cloud security and scalability considerations for web applications.

UNIT I: FUNDAMENTALS OF CLOUD COMPUTING (

Definition and characteristics of cloud computing, basic concept of cloud service models: IaaS, PaaS and SaaS, overview of cloud deployment models, overview of popular cloud platforms (AWS, Azure, GCP).

UNIT II: DEPLOYING WEB APPLICATIONS ON CLOUD (

Basic concept of deploying web applications on cloud platforms, overview of cloud hosting services, basic concept of domain and DNS configuration.

UNIT III: CLOUD STORAGE AND DATABASE SERVICES (

Overview of cloud storage services, basic concept of cloud database services (managed SQL/NoSQL), overview of data backup and recovery in the cloud.

UNIT IV: CONTAINERIZATION AND ORCHESTRATION (

Basic concept of containerization (Docker), overview of container orchestration (Kubernetes), basic concept of the benefits of containerization for web application deployment.

UNIT V: CLOUD SECURITY AND SCALABILITY (

Basic concept of cloud security practices, overview of identity and access management, basic concept of load balancing and auto-scaling, overview of cost optimization considerations.

TEXT BOOKS:

1. Rajkumar Buyya, Christian Vecchiola and S. Thamarai Selvi, Mastering Cloud Computing, McGraw Hill Education, 2013.
2. Arshdeep Bahga and Vijay Madisetti, Cloud Computing: A Hands-On Approach, Universities Press, 2014.
3. John Arundel and Justin Domingus, Cloud Native DevOps with Kubernetes, O'Reilly Media, 2019.

REFERENCE BOOKS:

1. Thomas Erl, Zaigham Mahmood and Ricardo Puttini, Cloud Computing: Concepts, Technology & Architecture, Pearson Education, 2013.
2. Nigel Poulton, Docker Deep Dive, Independently Published, 2020.
3. Kelsey Hightower, Brendan Burns and Joe Beda, Kubernetes: Up and Running, 2nd Edition, O'Reilly Media, 2019.

Multi-Disciplinary Minor (MDM): Cloud Computing (Offered by CSE to B.Tech. ME)

Detailed Syllabus

Session: 2026-27

Introduction to Cloud Computing + Google Cloud Foundation Certificate

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26CS01TH0307-2	Introduction to Cloud Computing + Google Cloud Foundation Certificate	MDM	03-00-00	50	50	03

Prerequisite: Basic Computer Networks, Basics of Programming.

Course Objectives:

1: To introduce the fundamental concepts, characteristics and service models of cloud computing.
2: To develop understanding of cloud deployment models and architecture.
3: To familiarize students with core Google Cloud Platform (GCP) services.
4: To develop understanding of cloud pricing, billing and resource management.
5: To prepare students for the Google Cloud Foundation-level certification.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts, characteristics and service models of cloud computing.

CO2: Describe cloud deployment models and cloud computing architecture.

CO3: Identify and describe core Google Cloud Platform (GCP) services.

CO4: Explain cloud pricing, billing and resource management practices.

CO5: Demonstrate foundational knowledge aligned with the Google Cloud Foundation-level certification.

UNIT I: INTRODUCTION TO CLOUD COMPUTING

Definition and characteristics of cloud computing, evolution of cloud computing, basic concept of cloud service models: IaaS, PaaS and SaaS, benefits and challenges of cloud computing.

UNIT II: CLOUD DEPLOYMENT MODELS AND ARCHITECTURE

Basic concept of cloud deployment models: public, private, hybrid and multi-cloud, overview of cloud computing architecture, basic concept of virtualization.

UNIT III: OVERVIEW OF GOOGLE CLOUD PLATFORM

Introduction to Google Cloud Platform (GCP), basic concept of the GCP resource hierarchy: projects, folders and organizations, overview of core GCP services: compute, storage and networking.

UNIT IV: CLOUD PRICING AND RESOURCE MANAGEMENT

Basic concept of cloud pricing models, overview of billing and cost management on GCP, basic concept of resource management and IAM basics.

UNIT V: FOUNDATIONS FOR CLOUD CERTIFICATION

Overview of the Google Cloud Foundation-level certification domains, basic concept of hands-on use of the GCP console, case studies of cloud adoption, overview of certification preparation guidance.

TEXT BOOKS:

1. Rajkumar Buyya, Christian Vecchiola and S. Thamarai Selvi, Mastering Cloud Computing, McGraw Hill Education, 2013.

2. Google Cloud, Google Cloud Fundamentals: Core Infrastructure, Official Google Cloud Training Material, latest edition.

3. Arshdeep Bahga and Vijay Madisetti, Cloud Computing: A Hands-On Approach, Universities Press, 2014.

REFERENCE BOOKS:

1. Thomas Erl, Zaigham Mahmood and Ricardo Puttini, Cloud Computing: Concepts, Technology & Architecture, Pearson Education, 2013.

2. Google Cloud Documentation, cloud.google.com/docs, Google LLC.

3. Dan Sullivan, Official Google Cloud Certified Associate Cloud Engineer Study Guide, Wiley, 2019.

Data Analytics + Google Cloud Data Analytics Certificate

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26CS01TH0407-2	Data Analytics + Google Cloud Data Analytics Certificate	MDM	03-00-00	50	50	03

Prerequisite: Introduction to Cloud Computing + Google Cloud Foundation Certificate, Basic Statistics.

Course Objectives:

1: To introduce the fundamentals of data analytics and the data analytics lifecycle.

2: To develop understanding of data storage and processing services on Google Cloud.

3: To familiarize students with big data processing and analytics tools on GCP.

4: To develop understanding of data visualization and reporting techniques.

5: To prepare students for the Google Cloud Data Analytics certification track.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamentals of data analytics and the data analytics lifecycle.

CO2: Describe data storage and processing services available on Google Cloud (e.g., BigQuery, Cloud Storage).

CO3: Apply big data processing and analytics tools on GCP for data analysis tasks.

CO4: Apply data visualization and reporting techniques for presenting analytical insights.

CO5: Demonstrate knowledge aligned with the Google Cloud Data Analytics certification track.

UNIT I: FUNDAMENTALS OF DATA ANALYTICS

Definition and scope of data analytics, basic concept of the data analytics lifecycle, overview of types of analytics: descriptive, diagnostic, predictive and prescriptive.

UNIT II: DATA STORAGE AND PROCESSING ON GCP

Overview of Google Cloud Storage services, basic concept of BigQuery, overview of data ingestion techniques on GCP.

UNIT III: BIG DATA PROCESSING AND ANALYTICS TOOLS

Overview of big data processing frameworks, basic concept of Dataflow and Dataproc, basic concept of data pipelines on GCP.

UNIT IV: DATA VISUALIZATION AND REPORTING

Basic concept of data visualization principles, overview of Looker Studio (Data Studio), basic concept of building dashboards and reports.

UNIT V: PREPARATION FOR DATA ANALYTICS CERTIFICATION

Overview of the Google Cloud Data Analytics certification domains, basic concept of hands-on use of analytics tools on GCP, case studies of data analytics projects, overview of certification preparation guidance.

TEXT BOOKS:

1. Valliappa Lakshmanan, Google BigQuery: The Definitive Guide, O'Reilly Media, 2019.

2. Google Cloud, Google Cloud Data Analytics Training Material, Official Google Cloud Training, latest edition.

3. Wes McKinney, Python for Data Analysis, 3rd Edition, O'Reilly Media, 2022.

REFERENCE BOOKS:

1. Jordan Tigani and Siddartha Naidu, Google BigQuery Analytics, Wiley, 2014.

2. Google Cloud Documentation, cloud.google.com/docs, Google LLC.

3. Peter Bruce and Andrew Bruce, Practical Statistics for Data Scientists, 2nd Edition, O'Reilly Media, 2020.

Cloud Engineering + Google Cloud Engineer Certificate

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26CS01TH0507-2	Cloud Engineering + Google Cloud Engineer Certificate	MDM	03-00-00	50	50	03

Prerequisite: Data Analytics + Google Cloud Data Analytics Certificate.

Course Objectives:

1: To introduce the fundamentals of cloud infrastructure engineering.

2: To develop understanding of compute, storage and networking services on GCP.

3: To familiarize students with deploying and managing applications on GCP.

4: To develop understanding of infrastructure as code and automation on GCP.

5: To prepare students for the Google Cloud Associate/Professional Cloud Engineer certification.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamentals of cloud infrastructure engineering.

CO2: Configure and manage compute, storage and networking services on GCP.

CO3: Deploy and manage applications on the Google Cloud Platform.

CO4: Apply infrastructure as code and automation practices on GCP.

CO5: Demonstrate knowledge aligned with the Google Cloud Engineer certification track.

UNIT I: FUNDAMENTALS OF CLOUD ENGINEERING

Basic concept of the role of a cloud engineer, overview of GCP compute options: Compute Engine, App Engine, Kubernetes Engine and Cloud Run.

UNIT II: STORAGE AND NETWORKING ON GCP

Overview of GCP storage options, basic concept of the virtual private cloud (VPC), overview of networking components on GCP.

UNIT III: APPLICATION DEPLOYMENT AND MANAGEMENT

Basic concept of deploying applications on GCP, overview of containerization using Docker and Kubernetes Engine, basic concept of application monitoring and logging.

UNIT IV: INFRASTRUCTURE AS CODE AND AUTOMATION

Basic concept of infrastructure as code, overview of Terraform/Deployment Manager, basic concept of automation and CI/CD on GCP.

UNIT V: PREPARATION FOR CLOUD ENGINEER CERTIFICATION

Overview of the Google Cloud Engineer certification domains, basic concept of hands-on GCP engineering

tasks, case studies of cloud infrastructure projects, overview of certification preparation guidance.

TEXT BOOKS:

1. Dan Sullivan, Official Google Cloud Certified Associate Cloud Engineer Study Guide, Wiley, 2019.
2. Google Cloud, Google Cloud Associate Cloud Engineer Training Material, Official Google Cloud Training, latest edition.
3. John Arundel and Justin Domingus, Cloud Native DevOps with Kubernetes, O'Reilly Media, 2019.

REFERENCE BOOKS:

1. Google Cloud Documentation, cloud.google.com/docs, Google LLC.
2. Kelsey Hightower, Brendan Burns and Joe Beda, Kubernetes: Up and Running, 2nd Edition, O'Reilly Media, 2019.
3. Yevgeniy Brikman, Terraform: Up and Running, 3rd Edition, O'Reilly Media, 2022.

Cloud Security Fundamentals + Google Cloud Cyber Security Certificate

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26CS01TH0607-2	Cloud Security Fundamentals + Google Cloud Cyber Security Certificate	MDM	03-00-00	50	50	03

Prerequisite: Cloud Engineering + Google Cloud Engineer Certificate.

Course Objectives:

1: To introduce the fundamentals of cloud security concepts and principles.
2: To develop understanding of identity and access management (IAM) in the cloud.
3: To familiarize students with data protection and encryption practices in cloud environments.
4: To develop understanding of network security and threat detection on GCP.
5: To prepare students for a foundational Google Cloud cyber security certification track.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamentals of cloud security concepts and the shared responsibility model.
CO2: Apply identity and access management (IAM) principles for securing cloud resources.
CO3: Apply data protection and encryption practices for cloud environments.
CO4: Explain network security and threat detection mechanisms on GCP.
CO5: Demonstrate knowledge aligned with a foundational Google Cloud cyber security certification track.

UNIT I: FUNDAMENTALS OF CLOUD SECURITY

Basic concept of cloud security concepts and principles, overview of the shared responsibility model, basic concept of common cloud security threats.

UNIT II: IDENTITY AND ACCESS MANAGEMENT

Basic concept of identity and access management (IAM), overview of roles and permissions on GCP, basic concept of multi-factor authentication.

UNIT III: DATA PROTECTION AND ENCRYPTION

Basic concept of data protection in the cloud, overview of encryption at rest and in transit, basic concept of key management services.

UNIT IV: NETWORK SECURITY AND THREAT DETECTION

Basic concept of network security on GCP: firewalls and VPC service controls, overview of threat detection tools on GCP, basic concept of security monitoring and logging.

UNIT V: PREPARATION FOR CLOUD SECURITY CERTIFICATION

Overview of foundational cloud security certification domains, basic concept of hands-on use of GCP security tools, case studies of cloud security incidents, overview of certification preparation guidance.

TEXT BOOKS:

1. Google Cloud, Google Cloud Security Training Material, Official Google Cloud Training, latest edition.

2. Vic (J.R.) Winkler, Securing the Cloud: Cloud Computer Security Techniques and Tactics, Syngress, 2011.

3. William Stallings, Cryptography and Network Security: Principles and Practice, 7th Edition, Pearson Education, 2017.

REFERENCE BOOKS:

1. Google Cloud Documentation, cloud.google.com/docs, Google LLC.

2. Chris Dotson, Practical Cloud Security: A Guide for Secure Design and Deployment, 2nd Edition, O'Reilly Media, 2023.

3. National Institute of Standards and Technology, NIST Special Publication 800-144: Guidelines on Security and Privacy in Public Cloud Computing, NIST.

Multi-Disciplinary Minor (MDM): Cyber Security (Offered by CSE to B.Tech. ME)

Detailed Syllabus

Session: 2026-27

Fundamentals of Network Security

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26CS01TH0307-3	Fundamentals of Network Security	MDM	03-00-00	50	50	03

Prerequisite: Basic Computer Networks, Basic Computer Knowledge.

Course Objectives:

1: To introduce the fundamental concepts and principles of network security.

2: To develop understanding of common network security threats and attacks.

3: To familiarize students with cryptographic techniques used for network security.

4: To develop understanding of network security protocols and mechanisms.

5: To provide exposure to firewalls, VPNs and intrusion detection systems.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts and principles of network security.

CO2: Describe common network security threats and attacks at a conceptual level.

CO3: Apply cryptographic techniques for securing network communication.

CO4: Explain network security protocols and mechanisms.

CO5: Describe the role of firewalls, VPNs and intrusion detection systems in network security.

UNIT I: INTRODUCTION TO NETWORK SECURITY

Need for network security, basic concept of security goals: confidentiality, integrity and availability, overview of security services and mechanisms, basic concept of the OSI security architecture.

UNIT II: NETWORK SECURITY THREATS AND ATTACKS

Basic concept of classification of security threats and attacks, conceptual overview of common attack categories: malware, phishing, denial of service and man-in-the-middle, basic concept of threat modeling.

UNIT III: CRYPTOGRAPHY FOR NETWORK SECURITY

Basic concept of symmetric and asymmetric cryptography, overview of hashing and digital signatures, basic concept of public key infrastructure (PKI).

UNIT IV: NETWORK SECURITY PROTOCOLS

Overview of network security protocols: SSL/TLS and IPSec, overview of secure email and web protocols, basic concept of wireless network security.

UNIT V: FIREWALLS, VPNS AND INTRUSION DETECTION

Basic concept of firewalls: types and architecture, overview of virtual private networks (VPN), basic concept of intrusion detection and prevention systems.

TEXT BOOKS:

1. William Stallings, Cryptography and Network Security: Principles and Practice, 7th Edition, Pearson Education, 2017.

2. Behrouz A. Forouzan, Cryptography and Network Security, 3rd Edition, McGraw Hill Education, 2015.

3. Charlie Kaufman, Radia Perlman and Mike Speciner, Network Security: Private Communication in a Public World, 2nd Edition, Prentice Hall, 2002.

REFERENCE BOOKS:

1. Michael E. Whitman and Herbert J. Mattord, Principles of Information Security, 6th Edition, Cengage Learning, 2018.

2. William Stallings, Network Security Essentials: Applications and Standards, 6th Edition, Pearson Education, 2016.

3. Eric Cole, Network Security Bible, 2nd Edition, Wiley, 2009.

Applied Cyber Defence

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26CS01TH0407-3	Applied Cyber Defence	MDM	03-00-00	50	50	03

Prerequisite: Fundamentals of Network Security.

Course Objectives:

1: To introduce the fundamental concepts and frameworks of cyber defence.

2: To develop understanding of security operations and incident response processes.

3: To familiarize students with vulnerability assessment and risk management.

4: To develop understanding of security monitoring and threat intelligence.

5: To provide exposure to defensive security tools and best practices.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts and frameworks of cyber defence.

CO2: Describe security operations and incident response processes.

CO3: Apply vulnerability assessment and risk management techniques.

CO4: Explain security monitoring and threat intelligence concepts.

CO5: Apply defensive security tools and best practices for organizational cyber defence.

UNIT I: FUNDAMENTALS OF CYBER DEFENCE

Concept of cyber defence, overview of cyber defence frameworks, basic concept of the defence-in-depth strategy, basic concept of cyber security governance.

UNIT II: SECURITY OPERATIONS AND INCIDENT RESPONSE

Basic concept of a security operations center (SOC), overview of the incident response lifecycle, basic concept of incident handling procedures.

UNIT III: VULNERABILITY ASSESSMENT AND RISK MANAGEMENT

Basic concept of vulnerability assessment, overview of risk assessment and management frameworks, basic concept of patch management.

UNIT IV: SECURITY MONITORING AND THREAT INTELLIGENCE

Basic concept of security information and event management (SIEM), overview of log analysis, basic concept of threat intelligence.

UNIT V: DEFENSIVE SECURITY TOOLS AND BEST PRACTICES

Overview of defensive security tools (antivirus, basic concept of endpoint detection and response), security awareness and best practices, case studies of cyber defence implementation.

TEXT BOOKS:

1. Michael E. Whitman and Herbert J. Mattord, Principles of Information Security, 6th Edition,

Cengage Learning, 2018.

2. Jason Andress, The Basics of Information Security: Understanding the Fundamentals of InfoSec in Theory and Practice, 2nd Edition, Syngress, 2014.

3. National Institute of Standards and Technology, Framework for Improving Critical Infrastructure Cybersecurity (NIST Cybersecurity Framework), latest edition.

REFERENCE BOOKS:

1. Chris Sanders and Jason Smith, Applied Network Security Monitoring: Collection, Detection, and Analysis, Syngress, 2013.

2. Cynthia Brumfield and Brian Haugli, Cybersecurity Risk Management: Mastering the Fundamentals Using the NIST Cybersecurity Framework, Wiley, 2021.

3. Don Murdoch, Blue Team Handbook: Incident Response Edition, 3rd Edition, CreateSpace, 2019.

Modern Cloud Security Architecture

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26CS01TH0507-3	Modern Cloud Security Architecture	MDM	03-00-00	50	50	03

Prerequisite: Applied Cyber Defence, Basics of Cloud Computing.

Course Objectives:

1: To introduce the fundamental concepts of cloud security architecture.

2: To develop understanding of identity and access management in cloud environments.

3: To familiarize students with data security and encryption in cloud systems.

4: To develop understanding of cloud network security and secure architecture design.

5: To provide exposure to compliance and governance frameworks for cloud security.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts of cloud security architecture.

CO2: Apply identity and access management principles in cloud environments.

CO3: Apply data security and encryption techniques in cloud systems.

CO4: Design secure cloud network architectures.

CO5: Discuss compliance and governance frameworks applicable to cloud security.

UNIT I: FUNDAMENTALS OF CLOUD SECURITY ARCHITECTURE

Basic concept of cloud computing security challenges, overview of the shared responsibility model, basic concept of cloud security architecture principles.

UNIT II: IDENTITY AND ACCESS MANAGEMENT IN CLOUD

Basic concept of identity and access management (IAM) in cloud environments, overview of single sign-on and federated identity, basic concept of privileged access management.

UNIT III: DATA SECURITY AND ENCRYPTION IN CLOUD

Basic concept of data classification and protection in the cloud, overview of encryption techniques for data at rest and in transit, basic concept of key management in cloud systems.

UNIT IV: CLOUD NETWORK SECURITY AND ARCHITECTURE DESIGN

Basic concept of secure cloud network design, overview of virtual network security controls, basic concept of zero trust architecture.

UNIT V: COMPLIANCE AND GOVERNANCE FOR CLOUD SECURITY

Overview of cloud security compliance frameworks (basic concept of ISO 27001 and SOC 2), overview of cloud security governance, case studies of cloud security architecture.

TEXT BOOKS:

1. Chris Dotson, Practical Cloud Security: A Guide for Secure Design and Deployment, 2nd Edition, O'Reilly Media, 2023.

2. Vic (J.R.) Winkler, Securing the Cloud: Cloud Computer Security Techniques and Tactics, Syngress, 2011.

3. Ben Malisow, CCSP (Certified Cloud Security Professional) Official Study Guide, 2nd Edition, Sybex, 2020.

REFERENCE BOOKS:

1. Thomas Erl, Zaigham Mahmood and Ricardo Puttini, Cloud Computing: Concepts, Technology & Architecture, Pearson Education, 2013.

2. National Institute of Standards and Technology, NIST Special Publication 800-144: Guidelines on Security and Privacy in Public Cloud Computing, NIST.

3. Cloud Security Alliance, Security Guidance for Critical Areas of Focus in Cloud Computing, latest edition.

Digital Forensics

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26CS01TH0607-3	Digital Forensics	MDM	03-00-00	50	50	03

Prerequisite: Modern Cloud Security Architecture, Applied Cyber Defence.

Course Objectives:

1: To introduce the fundamental concepts and process of digital forensics.

2: To develop understanding of evidence collection and preservation techniques.

3: To familiarize students with file system and operating system forensics.

4: To develop understanding of network and cloud forensics.

5: To provide exposure to forensic reporting and legal aspects of digital investigations.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts and process of digital forensics.

CO2: Apply evidence collection and preservation techniques in a forensically sound manner.

CO3: Describe file system and operating system forensic analysis techniques.

CO4: Explain network and cloud forensic investigation techniques.

CO5: Prepare forensic reports and discuss the legal aspects of digital investigations.

UNIT I: INTRODUCTION TO DIGITAL FORENSICS

Definition and scope of digital forensics, basic concept of the digital forensic investigation process, overview of types of digital forensics: disk, network, mobile and cloud.

UNIT II: EVIDENCE COLLECTION AND PRESERVATION

Basic concept of the chain of custody, overview of evidence acquisition techniques, basic concept of forensic imaging, data preservation best practices.

UNIT III: FILE SYSTEM AND OPERATING SYSTEM FORENSICS

Basic concept of file system forensics (overview of FAT and NTFS), basic concept of operating system artifacts, overview of recovering deleted files.

UNIT IV: NETWORK AND CLOUD FORENSICS

Basic concept of network forensics, overview of packet capture and analysis, basic concept of cloud forensics and its challenges.

UNIT V: FORENSIC REPORTING AND LEGAL ASPECTS

Basic concept of forensic report writing, overview of legal and ethical considerations in digital forensics, basic concept of admissibility of digital evidence, case studies of digital forensic investigations.

TEXT BOOKS:

1. Eoghan Casey, Digital Evidence and Computer Crime: Forensic Science, Computers, and the Internet, 3rd Edition, Academic Press, 2011.

2. Bill Nelson, Amelia Phillips and Christopher Steuart, Guide to Computer Forensics and Investigations, 6th Edition, Cengage Learning, 2018.

3. Darren R. Hayes, A Practical Guide to Digital Forensics Investigations, 2nd Edition, Pearson IT Certification, 2020.

REFERENCE BOOKS:

1. Harlan Carvey, Windows Forensic Analysis Toolkit, 4th Edition, Syngress, 2014.

2. Marjie T. Britz, Computer Forensics and Cyber Crime: An Introduction, 3rd Edition, Pearson Education, 2013.

3. Cory Altheide and Harlan Carvey, Digital Forensics with Open Source Tools, Syngress, 2011.

Multi-Disciplinary Minor (MDM): Civil Engineering for Sustainable Development (Offered by Civil Engg. to B.Tech. ME)

Detailed Syllabus

Session: 2026-27

Fundamentals of Civil Infrastructure and Construction

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26ES01TH0305	Fundamentals of Civil Infrastructure and Construction	MDM	03-00-00	50	50	03

Prerequisite: Basic Physics, Basic Mathematics.

Course Objectives:

1: To introduce the fundamental concepts of civil engineering infrastructure.

2: To develop understanding of building components and construction terminology.

3: To familiarize students with basic surveying and site planning concepts.

4: To develop understanding of construction materials used in civil infrastructure.

5: To provide exposure to the construction project lifecycle.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts and scope of civil engineering infrastructure.

CO2: Describe building components and basic construction terminology.

CO3: Explain basic surveying and site planning concepts.

CO4: Describe common construction materials used in civil infrastructure.

CO5: Explain the phases of the construction project lifecycle.

UNIT I: INTRODUCTION TO CIVIL INFRASTRUCTURE

Scope of civil engineering, overview of types of civil infrastructure: buildings, roads, bridges and water supply, role of civil engineering in national development.

UNIT II: BUILDING COMPONENTS AND CONSTRUCTION TERMINOLOGY

Basic components of a building: foundation, superstructure and roof, overview of construction terminology, basic concept of types of buildings based on occupancy.

UNIT III: SURVEYING AND SITE PLANNING

Basic concept of surveying, overview of surveying instruments, basic concept of site planning and layout, basic concept of site investigation.

UNIT IV: CONSTRUCTION MATERIALS OVERVIEW

Overview of basic construction materials: cement, aggregates, bricks and steel, basic concept of properties of construction materials, overview of material selection criteria.

UNIT V: CONSTRUCTION PROJECT LIFECYCLE

Basic concept of the phases of a construction project: planning, design, execution and closure, overview of stakeholders in construction projects, introduction to construction documentation.

TEXT BOOKS:

1. S. C. Rangwala, Building Construction, 10th Edition, Charotar Publishing House, 2016.

2. B. C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, Building Construction, 11th Edition, Laxmi Publications, 2012.

3. Roger Greeno, Building Construction Handbook, 12th Edition, Routledge, 2020.

REFERENCE BOOKS:

1. M. S. Shetty, Concrete Technology: Theory and Practice, 8th Edition, S. Chand Publishing, 2019.
2. S. K. Duggal, Building Materials, 4th Edition, New Age International, 2016.
3. K. K. Chitkara, Construction Project Management: Planning, Scheduling and Controlling, 3rd Edition, McGraw Hill Education, 2014.

Construction Materials and Technology

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26ES01TH0404	Construction Materials and Technology	MDM	03-00-00	50	50	03

Prerequisite: Fundamentals of Civil Infrastructure and Construction.

Course Objectives:

1: To introduce the properties and classification of construction materials.
2: To develop understanding of cement, concrete and their properties.
3: To familiarize students with steel and timber as construction materials.
4: To develop understanding of modern and alternative construction materials.
5: To provide exposure to material testing and quality control in construction.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the properties and classification of construction materials.
CO2: Describe the properties and applications of cement and concrete.
CO3: Explain the properties and applications of steel and timber in construction.
CO4: Describe modern and alternative construction materials.
CO5: Apply material testing and quality control procedures for construction materials.

UNIT I: CLASSIFICATION AND PROPERTIES OF CONSTRUCTION MATERIALS

Classification of construction materials, basic concept of physical and mechanical properties of materials, factors affecting material selection.

UNIT II: CEMENT AND CONCRETE

Basic concept of types and properties of cement, concrete: constituents and properties, basic concept of concrete mix design, overview of special concretes.

UNIT III: STEEL AND TIMBER

Basic concept of properties and types of structural steel, overview of steel reinforcement, basic concept of timber properties and classification, overview of timber seasoning and preservation.

UNIT IV: MODERN AND ALTERNATIVE MATERIALS

Overview of modern construction materials: composites and polymers, overview of alternative and sustainable materials: fly ash and recycled aggregates, basic concept of smart materials in construction.

UNIT V: MATERIAL TESTING AND QUALITY CONTROL

Basic concept of testing of construction materials, overview of quality control procedures in construction, basic concept of relevant standards and codes, case studies of material failures.

TEXT BOOKS:

1. M. S. Shetty, Concrete Technology: Theory and Practice, 8th Edition, S. Chand Publishing, 2019.
2. S. K. Duggal, Building Materials, 4th Edition, New Age International, 2016.
3. P. C. Varghese, Building Materials, 2nd Edition, PHI Learning, 2015.

REFERENCE BOOKS:

1. A. M. Neville, Properties of Concrete, 5th Edition, Pearson Education, 2011.
2. J. M. Ilston and P. L. J. Domone, Construction Materials: Their Nature and Behaviour, 4th Edition, CRC Press, 2010.
3. Bureau of Indian Standards, relevant IS codes on construction materials.

Green Building Construction and Environmental Systems

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26ES01TH0506	Green Building Construction and Environmental Systems	MDM	03-00-00	50	50	03

Prerequisite: Construction Materials and Technology.

Course Objectives:

1: To introduce the fundamental concepts and principles of green building construction.
2: To develop understanding of energy-efficient building design.
3: To familiarize students with sustainable materials and construction practices.
4: To develop understanding of water and waste management systems in buildings.
5: To provide exposure to green building rating systems and certification.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts and principles of green building construction.
CO2: Describe energy-efficient building design strategies.
CO3: Apply sustainable materials and construction practices in building design.
CO4: Describe water and waste management systems in green buildings.
CO5: Discuss green building rating systems and certification processes.

UNIT I: INTRODUCTION TO GREEN BUILDING

Concept of sustainable development and green buildings, basic concept of principles of green building design, overview of benefits of green buildings.

UNIT II: ENERGY-EFFICIENT BUILDING DESIGN

Basic concept of passive design strategies, overview of building orientation and daylighting, basic concept of energy-efficient HVAC systems, overview of renewable energy integration in buildings.

UNIT III: SUSTAINABLE MATERIALS AND CONSTRUCTION PRACTICES

Basic concept of sustainable and eco-friendly building materials, overview of low-carbon construction practices, basic concept of life cycle assessment of building materials.

UNIT IV: WATER AND WASTE MANAGEMENT SYSTEMS

Basic concept of rainwater harvesting, overview of water conservation and recycling in buildings, basic concept of solid waste management in construction, overview of wastewater treatment systems.

UNIT V: GREEN BUILDING RATING AND CERTIFICATION

Overview of green building rating systems (basic concept of LEED, GRIHA and IGBC), overview of the certification process, case studies of certified green buildings.

TEXT BOOKS:

1. Charles J. Kibert, Sustainable Construction: Green Building Design and Delivery, 4th Edition, Wiley, 2016.

2. The Energy and Resources Institute (TERI), GRIHA Manual (Volumes 1-5), latest edition.

3. Sam Kubba, Handbook of Green Building Design and Construction: LEED, BREEAM, and Green Globes, 2nd Edition, Butterworth-Heinemann, 2017.

REFERENCE BOOKS:

1. Norbert Lechner, Heating, Cooling, Lighting: Sustainable Design Methods for Architects, 4th Edition, Wiley, 2014.

2. U.S. Green Building Council (USGBC), LEED Reference Guide for Building Design and Construction, latest edition.

3. Indian Green Building Council (IGBC), IGBC Green New Buildings Rating System, latest edition.

Building Construction Methods and Management

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26ES01TH0607	Building Construction Methods and Management	MDM	03-00-00	50	50	03

Prerequisite: Green Building Construction and Environmental Systems.

Course Objectives:

1: To introduce modern building construction methods and techniques.

2: To develop understanding of formwork, scaffolding and construction equipment.

3: To familiarize students with construction planning and scheduling techniques.

4: To develop understanding of construction cost estimation and budgeting.

5: To provide exposure to construction safety and quality management practices.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain modern building construction methods and techniques.

CO2: Describe formwork, scaffolding and construction equipment used in building construction.

CO3: Apply construction planning and scheduling techniques for building projects.

CO4: Apply construction cost estimation and budgeting techniques.

CO5: Discuss construction safety and quality management practices.

UNIT I: MODERN CONSTRUCTION METHODS

Conventional versus modern construction methods, basic concept of prefabricated construction, overview of formwork systems, basic concept of construction methods for high-rise buildings.

UNIT II: FORMWORK, SCAFFOLDING AND EQUIPMENT

Basic concept of types of formwork, overview of scaffolding systems, basic concept of construction equipment: earthmoving, concreting and lifting equipment.

UNIT III: CONSTRUCTION PLANNING AND SCHEDULING

Basic concept of the construction planning process, overview of scheduling techniques: bar charts and CPM/PERT, basic concept of resource planning for construction projects.

UNIT IV: CONSTRUCTION COST ESTIMATION AND BUDGETING

Basic concept of construction cost estimation, overview of methods of estimation, basic concept of budgeting and cost control in construction projects.

UNIT V: CONSTRUCTION SAFETY AND QUALITY MANAGEMENT

Basic concept of construction safety practices and regulations, overview of quality management in construction, case studies of construction project management.

TEXT BOOKS:

1. K. K. Chitkara, Construction Project Management: Planning, Scheduling and Controlling, 3rd Edition, McGraw Hill Education, 2014.

2. B. C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, Project Planning and Control with PERT and CPM, 6th Edition, Laxmi Publications, 2003.

3. S. Seetharaman, Construction Engineering and Management, Umesh Publications, 2013.

REFERENCE BOOKS:

1. Chris Hendrickson and Tung Au, Project Management for Construction: Fundamental Concepts for Owners, Engineers, Architects and Builders, 2nd Edition, Prentice Hall, 2008.

2. Sidney M. Levy, Project Management in Construction, 7th Edition, McGraw Hill Education, 2018.

3. Bureau of Indian Standards, National Building Code of India (NBC), latest edition.

Multi-Disciplinary Minor (MDM): Renewable Energy and E-mobility (Offered by Electrical Engg. to B.Tech. ME)

Detailed Syllabus

Session: 2026-27

Introduction to Renewable Energy Sources

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE07TH0309	Introduction to Renewable Energy Sources	MDM	03-00-00	50	50	03

Prerequisite: Basic Physics, Basic Electrical Engineering.

Course Objectives:

1: To introduce the fundamental concepts and need for renewable energy sources.

2: To develop understanding of solar energy technologies.

3: To familiarize students with wind energy technologies.

4: To develop understanding of biomass, geothermal and other renewable energy sources.

5: To provide exposure to renewable energy integration and policy framework.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts and need for renewable energy sources.

CO2: Describe solar energy technologies and their applications.

CO3: Describe wind energy technologies and their applications.

CO4: Explain biomass, geothermal and other renewable energy technologies.

CO5: Discuss renewable energy grid integration and relevant policy frameworks.

UNIT I: INTRODUCTION TO RENEWABLE ENERGY

Conventional versus renewable energy sources, need for renewable energy, overview of the global and Indian renewable energy scenario, environmental benefits of renewable energy.

UNIT II: SOLAR ENERGY TECHNOLOGIES

Basic concept of solar radiation, overview of solar thermal systems, basic concept of solar photovoltaic systems: principle and types, applications of solar energy.

UNIT III: WIND ENERGY TECHNOLOGIES

Basic concept of wind energy potential, overview of wind turbine types and components, basic concept of wind farm layout, applications of wind energy.

UNIT IV: BIOMASS, GEOTHERMAL AND OTHER RENEWABLE SOURCES

Basic concept of biomass and biogas energy, overview of geothermal energy, basic concept of tidal and ocean energy, overview of hydrogen energy and fuel cells.

UNIT V: RENEWABLE ENERGY INTEGRATION AND POLICY

Basic concept of grid integration of renewable energy, overview of energy storage for renewable integration, basic concept of renewable energy policies and incentives in India.

TEXT BOOKS:

1. G. D. Rai, Non-Conventional Energy Sources, 5th Edition, Khanna Publishers, 2011.
2. B. H. Khan, Non-Conventional Energy Resources, 3rd Edition, McGraw Hill Education, 2017.

3. Godfrey Boyle, Renewable Energy: Power for a Sustainable Future, 3rd Edition, Oxford University Press, 2012.

REFERENCE BOOKS:

1. C. S. Solanki, Renewable Energy Technologies: A Practical Guide for Beginners, 2nd Edition, PHI Learning, 2015.

2. D. Yogi Goswami, Frank Kreith and Jan F. Kreider, Principles of Solar Engineering, 3rd Edition, CRC Press, 2015.

3. Ministry of New and Renewable Energy (MNRE), Government of India, Annual Report, latest edition.

EV Architecture and Components

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE07TH0409	EV Architecture and Components	MDM	03-00-00	50	50	03

Prerequisite: Introduction to Renewable Energy Sources, Basic Electrical Engineering.

Course Objectives:

1: To introduce the fundamental architecture of electric vehicles.

2: To develop understanding of EV powertrain configurations.

3: To familiarize students with electric motors and power electronic components used in EVs.

4: To develop understanding of EV battery and charging systems.

5: To provide exposure to EV subsystem integration.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental architecture of electric vehicles.

CO2: Describe various electric vehicle powertrain configurations.

CO3: Describe electric motors and power electronic components used in EVs.

CO4: Explain EV battery and charging systems.

CO5: Discuss the integration of EV subsystems into a complete vehicle architecture.

UNIT I: INTRODUCTION TO EV ARCHITECTURE

Overview of electric vehicles: BEV, HEV, PHEV and FCEV, basic concept of EV architecture and subsystems, comparison with conventional vehicles.

UNIT II: EV POWERTRAIN CONFIGURATIONS

Basic concept of series, parallel and series-parallel hybrid configurations, overview of powertrain sizing considerations, basic concept of regenerative braking.

UNIT III: ELECTRIC MOTORS AND POWER ELECTRONICS IN EVS

Overview of traction motors used in EVs, basic concept of power electronic converters in EVs, overview of motor drive and control.

UNIT IV: EV BATTERY AND CHARGING SYSTEMS

Basic concept of EV battery types and characteristics, overview of the battery management system (BMS), basic concept of EV charging methods and standards.

UNIT V: EV SUBSYSTEM INTEGRATION

Basic concept of integration of motor, battery and power electronics, overview of thermal management in EVs, case studies of EV architecture.

TEXT BOOKS:

1. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, 3rd Edition, CRC Press, 2021.
2. James Larminie and John Lowry, Electric Vehicle Technology Explained, 2nd Edition, Wiley, 2012.
3. Mehrdad Ehsani, Yimin Gao, Stefano Longo and Kambiz Ebrahimi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, 3rd Edition, CRC Press, 2018.

REFERENCE BOOKS:

1. Chris Mi, M. Abul Masrur and David Wenzhong Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, 2nd Edition, Wiley, 2017.
2. Sandeep Dhameja, Electric Vehicle Battery Systems, Newnes, 2001.
3. Ali Emadi, Advanced Electric Drive Vehicles, CRC Press, 2014.

Energy Storage Systems in E-Mobility

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE07TH0509	Energy Storage Systems in E-Mobility	MDM	03-00-00	50	50	03

Prerequisite: EV Architecture and Components.

Course Objectives:

1: To introduce the fundamental concepts and classification of energy storage systems for e-mobility.
2: To develop understanding of battery chemistry and characteristics for EV applications.
3: To familiarize students with battery pack design and thermal management.
4: To develop understanding of battery management systems and state estimation.
5: To provide exposure to alternative energy storage technologies and second-life applications.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts and classification of energy storage systems for e-mobility.
CO2: Describe battery chemistry and characteristics relevant to EV applications.
CO3: Explain battery pack design considerations and thermal management systems.
CO4: Describe battery management systems and state estimation techniques.
CO5: Discuss alternative energy storage technologies and second-life battery applications.

UNIT I: INTRODUCTION TO ENERGY STORAGE FOR E-MOBILITY

Need for energy storage in EVs, basic concept of classification of energy storage systems, overview of key performance parameters of energy storage.

UNIT II: BATTERY CHEMISTRY AND CHARACTERISTICS

Overview of battery chemistries used in EVs: lithium-ion (LFP, NMC, NCA), basic concept of battery characteristics: capacity, energy density and C-rate.

UNIT III: BATTERY PACK DESIGN AND THERMAL MANAGEMENT

Basic concept of cell to pack design, overview of series-parallel configuration, basic concept of thermal runaway and thermal management systems.

UNIT IV: BATTERY MANAGEMENT SYSTEMS AND STATE ESTIMATION

Basic concept of BMS functions, overview of cell balancing techniques, basic concept of state of charge (SOC) and state of health (SOH) estimation.

UNIT V: ALTERNATIVE STORAGE AND SECOND-LIFE APPLICATIONS

Overview of alternative energy storage technologies: supercapacitors and fuel cells, basic concept of battery recycling and second-life applications, case studies of energy storage in e-mobility.

TEXT BOOKS:

1. Sandeep Dhameja, Electric Vehicle Battery Systems, Newnes, 2001.
2. Gregory L. Plett, Battery Management Systems, Volume I: Battery Modeling, Artech House, 2015.
3. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, 3rd Edition, CRC Press, 2021.

REFERENCE BOOKS:

1. Davide Andrea, Battery Management Systems for Large Lithium-Ion Battery Packs, Artech House, 2010.
2. Reiner Korthauer (Ed.), Lithium-Ion Batteries: Basics and Applications, Springer, 2018.
3. Bruno Scrosati, Jurgen Garche and Werner Tillmetz (Eds.), Advances in Battery Technologies for Electric Vehicles, Woodhead Publishing, 2015.

Autonomous Vehicle

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26EE07TH0609	Autonomous Vehicle	MDM	03-00-00	50	50	03

Prerequisite: EV Architecture and Components, Basics of Sensors and Control Systems.

Course Objectives:

1: To introduce the fundamental concepts and levels of vehicle autonomy.

2: To develop understanding of sensors used in autonomous vehicles.

3: To familiarize students with perception and localization techniques for autonomous vehicles.

4: To develop understanding of path planning and vehicle control for autonomous driving.

5: To provide exposure to safety, regulations and challenges in autonomous vehicle deployment.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts and levels of vehicle autonomy.

CO2: Describe sensors used in autonomous vehicles (LiDAR, camera, radar, ultrasonic).

CO3: Explain perception and localization techniques used in autonomous vehicles.

CO4: Describe path planning and vehicle control techniques for autonomous driving.

CO5: Discuss safety, regulatory and technological challenges in autonomous vehicle deployment.

UNIT I: INTRODUCTION TO AUTONOMOUS VEHICLES

Basic concept of levels of vehicle autonomy (SAE Levels 0-5), history and evolution of autonomous vehicles, applications of autonomous vehicles.

UNIT II: SENSORS FOR AUTONOMOUS VEHICLES

Overview of LiDAR, camera, radar and ultrasonic sensors, basic concept of sensor fusion, overview of sensor placement and calibration.

UNIT III: PERCEPTION AND LOCALIZATION

Basic concept of object detection and classification, basic concept of localization techniques: GPS and SLAM, overview of mapping for autonomous vehicles.

UNIT IV: PATH PLANNING AND VEHICLE CONTROL

Basic concept of path planning algorithms, overview of trajectory generation, basic concept of vehicle control systems for autonomous driving.

UNIT V: SAFETY, REGULATIONS AND CHALLENGES

Basic concept of functional safety in autonomous vehicles, overview of the regulatory framework for autonomous vehicles, ethical and technological challenges, case studies of autonomous vehicle deployment.

TEXT BOOKS:

1. Shaoshan Liu, Liyun Li, Jie Tang, Shuang Wu and Jean-Luc Gaudiot, Creating Autonomous Vehicle Systems, 2nd Edition, Morgan & Claypool, 2020.

2. Hong Cheng, Autonomous Intelligent Vehicles: Theory, Algorithms, and Implementation, Springer, 2011.

3. Ali Emadi, Advanced Electric Drive Vehicles, CRC Press, 2014.

REFERENCE BOOKS:

1. Azim Eskandarian (Ed.), Handbook of Intelligent Vehicles, Springer, 2012.

2. SAE International, Taxonomy and Definitions for Terms Related to Driving Automation Systems (SAE J3016), latest edition.

3. Massimo Bertozzi, Alberto Broggi and Alessandra Fascioli, Vision-Based Intelligent Vehicles: State of the Art and Perspectives, reference compilation.

Multi-Disciplinary Minor (MDM) offered by MBA to ME students: Project Management

Detailed Syllabus

Session: 2026-27

Introduction to Engineering Project Management

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26MT04TH0307	Introduction to Engineering Project Management	MDM	03-00-00	50	50	03

Prerequisite: Nil.

Course Objectives:

The objectives of this course are: To enable students to understand the fundamental concepts, principles and lifecycle of project management applicable to engineering projects.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the concept, scope and importance of project management in engineering.

CO2: Describe the project life cycle and organizational structures for project management.

CO3: Explain the process of project selection and initiation.

CO4: Describe the role of project managers and stakeholder management in engineering projects.

CO5: Explain basic project management tools and techniques used in engineering practice.

UNIT I: INTRODUCTION TO PROJECT MANAGEMENT

Definition and characteristics of a project, difference between project and operations, importance of project management in engineering, evolution of project management, overview of project management knowledge areas.

UNIT II: PROJECT LIFE CYCLE AND ORGANIZATION

Project life cycle phases: initiation, planning, execution, monitoring and closure, project organizational structures: functional, matrix and projectized, roles and responsibilities in project organizations.

UNIT III: PROJECT SELECTION AND INITIATION

Project identification and feasibility analysis, overview of project selection methods: payback period, net present value and internal rate of return, project charter, project scope statement.

UNIT IV: PROJECT MANAGER AND STAKEHOLDER MANAGEMENT

Role and responsibilities of a project manager, skills required for project management, stakeholder identification and analysis, stakeholder communication and engagement strategies.

UNIT V: PROJECT MANAGEMENT TOOLS AND TECHNIQUES

Overview of project management software tools, work breakdown structure (WBS), basics of project documentation, introduction to project management standards and certifications (overview of PMI and PMBOK).

TEXT BOOKS:

1. Project Management Institute, A Guide to the Project Management Body of Knowledge (PMBOK Guide), 7th Edition, PMI, 2021.
2. Harold Kerzner, Project Management: A Systems Approach to Planning, Scheduling, and Controlling, 12th Edition, Wiley, 2017.
3. Prasanna Chandra, Projects: Planning, Analysis, Selection, Financing, Implementation, and Review, 9th Edition, McGraw Hill Education, 2019.

REFERENCE BOOKS:

1. Jack R. Meredith and Samuel J. Mantel Jr., Project Management: A Managerial Approach, 10th Edition, Wiley, 2017.
2. Clifford F. Gray and Erik W. Larson, Project Management: The Managerial Process, 7th Edition, McGraw Hill Education, 2017.
3. K. Nagarajan, Project Management, 6th Edition, New Age International, 2015.

Project Planning, Scheduling, and Cost Control

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26MT04TH0407	Project Planning, Scheduling, and Cost Control	MDM	03-00-00	50	50	03

Prerequisite: Introduction to Engineering Project Management.

Course Objectives:

The objectives of this course are: To enable students to apply project planning, scheduling and cost control techniques for the effective management of engineering projects.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Develop work breakdown structures and project scope documents for engineering projects.

CO2: Apply network techniques (CPM/PERT) for project scheduling.

CO3: Apply resource allocation and resource leveling techniques for project scheduling.

CO4: Estimate project costs and prepare project budgets.

CO5: Apply earned value management techniques for project cost and schedule control.

UNIT I: PROJECT PLANNING

Project planning process, work breakdown structure (WBS): development and levels, project scope management,

project planning documents, linking WBS with organizational structure.

UNIT II: PROJECT SCHEDULING - CPM AND PERT

Network construction techniques, Critical Path Method (CPM): activity duration estimation, forward and backward pass and float calculation, Program Evaluation and Review Technique (PERT): probabilistic time estimates, basic concept of project crashing.

UNIT III: RESOURCE MANAGEMENT AND SCHEDULING

Resource allocation and resource leveling, resource-constrained scheduling, Gantt charts, resource histograms, overview of multi-project resource scheduling.

UNIT IV: PROJECT COST ESTIMATION AND BUDGETING

Types of cost estimates, cost estimation techniques, project budgeting process, cost baseline development, basic concept of contingency and management reserves.

UNIT V: PROJECT COST CONTROL - EARNED VALUE MANAGEMENT

Earned value management (EVM) concepts: planned value, earned value and actual cost, schedule variance and cost variance, schedule performance index and cost performance index, forecasting project completion using EVM.

TEXT BOOKS:

1. Harold Kerzner, Project Management: A Systems Approach to Planning, Scheduling, and Controlling, 12th Edition, Wiley, 2017.

2. Jack R. Meredith and Samuel J. Mantel Jr., Project Management: A Managerial Approach, 10th Edition, Wiley, 2017.

3. Quentin W. Fleming and Joel M. Koppelman, Earned Value Project Management, 4th Edition, Project Management Institute, 2010.

REFERENCE BOOKS:

1. Clifford F. Gray and Erik W. Larson, Project Management: The Managerial Process, 7th Edition, McGraw Hill Education, 2017.

2. Project Management Institute, A Guide to the Project Management Body of Knowledge (PMBOK Guide), 7th Edition, PMI, 2021.

3. K. K. Chitkara, Construction Project Management: Planning, Scheduling and Controlling, 3rd Edition, McGraw Hill Education, 2014.

Engineering Project Risk, Quality, and Leadership

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26MT04TH0507	Engineering Project Risk, Quality, and Leadership	MDM	03-00-00	50	50	03

Prerequisite: Project Planning, Scheduling, and Cost Control.

Course Objectives:

The objectives of this course are: To enable students to understand and apply risk management, quality

management and leadership principles for the effective management of engineering projects.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the concepts and process of project risk management.

CO2: Apply risk identification, analysis and response planning techniques for engineering projects.

CO3: Apply quality management principles and tools for engineering project quality assurance.

CO4: Explain leadership styles and team management principles for project teams.

CO5: Analyze conflict management and negotiation techniques in project environments.

UNIT I: PROJECT RISK MANAGEMENT - INTRODUCTION

Concept of risk in projects, risk management process: planning, identification, analysis, response and monitoring, categories of project risk, basic concept of the risk management plan.

UNIT II: RISK IDENTIFICATION, ANALYSIS AND RESPONSE

Risk identification techniques: brainstorming, checklist and SWOT analysis, qualitative and quantitative risk analysis, probability-impact matrix, risk response strategies: avoid, transfer, mitigate and accept.

UNIT III: PROJECT QUALITY MANAGEMENT

Quality management concepts: quality planning, quality assurance and quality control, overview of quality tools: cause-effect diagram, Pareto chart and control charts, cost of quality, continuous improvement in projects.

UNIT IV: LEADERSHIP AND TEAM MANAGEMENT

Leadership styles and theories, role of a project leader, team building and team development stages, basic concept of motivation theories, effective communication in project teams.

UNIT V: CONFLICT MANAGEMENT AND NEGOTIATION

Sources and types of conflict in projects, conflict resolution techniques, negotiation strategies and skills, stakeholder conflict management, case studies in project leadership and conflict resolution.

TEXT BOOKS:

1. Harold Kerzner, Project Management: A Systems Approach to Planning, Scheduling, and Controlling, 12th Edition, Wiley, 2017.

2. Project Management Institute, A Guide to the Project Management Body of Knowledge (PMBOK Guide), 7th Edition, PMI, 2021.

3. Stephen P. Robbins and Timothy A. Judge, Organizational Behavior, 18th Edition, Pearson Education, 2019.

REFERENCE BOOKS:

1. Clifford F. Gray and Erik W. Larson, Project Management: The Managerial Process, 7th Edition, McGraw Hill Education, 2017.

2. Roger Fisher and William Ury, Getting to Yes: Negotiating Agreement Without Giving In, 3rd Edition, Penguin Books, 2011.

3. James P. Lewis, Project Planning, Scheduling, and Control, 5th Edition, McGraw Hill Education, 2011.

Advanced Project Management & Capstone for Engineers

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
26MT04TH0607	Advanced Project Management & Capstone for Engineers	MDM	03-00-00	50	50	03

Prerequisite: Engineering Project Risk, Quality, and Leadership.

Course Objectives:

The objectives of this course are: To enable students to apply advanced project management concepts including agile methodologies, program and portfolio management, and to integrate project management knowledge through a capstone application in an engineering context.

Course Outcomes

On successful completion of the course, students will be able to:

CO1: Explain the principles of agile and hybrid project management methodologies.

CO2: Describe program management and project portfolio management concepts.

CO3: Analyze project procurement and contract management practices in engineering projects.

CO4: Apply project management maturity and organizational project management concepts.

CO5: Integrate project management knowledge through a capstone project application for an engineering scenario.

UNIT I: AGILE AND HYBRID PROJECT MANAGEMENT

Introduction to agile project management, agile principles and values, Scrum framework: roles, events and artifacts, basic concept of Kanban, hybrid project management approaches.

UNIT II: PROGRAM AND PORTFOLIO MANAGEMENT

Difference between project, program and portfolio management, program management concepts, portfolio selection and prioritization, alignment of projects with organizational strategy.

UNIT III: PROJECT PROCUREMENT AND CONTRACT MANAGEMENT

Procurement management process, types of contracts, vendor selection and evaluation, basic concept of contract administration, claims and dispute resolution in engineering projects.

UNIT IV: PROJECT MANAGEMENT MATURITY AND GOVERNANCE

Overview of project management maturity models, organizational project management, project governance structures, project management office (PMO): roles and functions.

UNIT V: CAPSTONE PROJECT APPLICATION

Integration of project management knowledge areas, development of a comprehensive project management plan for an engineering scenario, application of planning, scheduling, cost, risk, quality and leadership concepts, presentation and evaluation of capstone project work.

TEXT BOOKS:

1. Project Management Institute, A Guide to the Project Management Body of Knowledge (PMBOK Guide), 7th Edition, PMI, 2021.

2. Harold Kerzner, Project Management: A Systems Approach to Planning, Scheduling, and Controlling, 12th Edition, Wiley, 2017.

3. Jeff Sutherland, Scrum: The Art of Doing Twice the Work in Half the Time, Currency, 2014.

REFERENCE BOOKS:

1. Project Management Institute, The Standard for Program Management, 4th Edition, PMI, 2017.
2. Project Management Institute, The Standard for Portfolio Management, 4th Edition, PMI, 2017.
3. Clifford F. Gray and Erik W. Larson, Project Management: The Managerial Process, 7th Edition, McGraw Hill Education, 2017.