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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 2025-26)

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.

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I - Internal Evaluation, E - External Evaluation

SEMESTER - I												
SN	Course Type	Course Code	Course Name	Hours/Week			Credits	Maximum Marks			Total	ESE Duration (Hrs.)
				L	P	S		Cont. Evaluation		End Sem Exam		
								TH	PR			
1	BSC	25HS03TP0107	Differential Calculus and Basics of Statistics	3	2	2	4	50	50	50	150	3
2	ESC	25EE07TP0106	Basics of Electrical Engineering	2	2	2	3	50	50	50	150	2
3	ESC	25ES04TH0101	Engineering Mechanics	3	0	1	3	50	-	50	100	3
4	ESC	25ES04TP0102	Engineering Graphics	2	2	2	3	50	50	50	150	2
5	ESC	25ES04TP0103	Programming for Problem Solving	2	2	2	3	50	50	-	100	-
6	AEC/ HSSM	25HS02TP0101	English for Professional Communication	2	2	1	3	50	25	50+25	150	2
7	VEC/ HSSM	25HS02TH0104	Foundational Course in Universal Human Values	1	0	1	1	50	-	-	50	-
TOTAL				**15**	**10**	**9**	**20**	**350**	**225**	**200**	**850**	**12**

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	25HS02PR0102-2	Fundamentals of Indian Classical Dance: Bharatnatayam	0	2	1	25	25	50	- -
2	25HS02PR0102-3	Fundamentals of Indian Classical Dance: Kathak	0	2	1	25	25	50	- -
3	25HS02PR0102-4	Introduction to Digital Photography	0	2	1	25	25	50	- -
4	25HS02PR0102-5	Introduction to Basic Japanese Language	0	2	1	25	25	50	- -
5	25HS02PR0102-6	Art of Theatre	0	2	1	25	25	50	- -
6	25HS02PR0102-7	Introduction to French Language	0	2	1	25	25	50	- -
7	25HS02PR0102-8	Introduction to Spanish Language	0	2	1	25	25	50	- -
8	25HS02PR0102-9	Art of Painting	0	2	1	25	25	50	- -
9	25HS02PR0102- 10	Art of Drawing	0	2	1	25	25	50	- -
10	25HS02PR0102- 11	Nature Camp	0	2	1	25	25	50	- -
11	25HS02PR0102- 12	Developing Self-awareness	0	2	1	25	25	50	- -
12	25HS02PR0102- 13	Art of Poetry	0	2	1	25	25	50	- -
13	25HS02PR0102-14	Creative and Content Writing	0	2	1	25	25	50	- -
14	25HS02PR0102-15	Science of life through Bhagwad Gita	0	2	1	25	25	50	- -
15	25HS02PR0102-16	Sanskrit Sambhashan-Spoken Sanskrit	0	2	1	25	25	50	- -
16	25HS02PR0102-17	Kirtan Kala	0	2	1	25	25	50	- -
17	25HS02PR0102- 18	Introduction to German Language and Culture	0	2	1	25	25	50	- -
18	25HS02PR0202-19	Adventure Sports	0	2	1	25	25	50	- -
19	25HS02PR0202-20	Introduction to Defense Forces & Obstacle Training	0	2	1	25	25	50	- -
20	25HS02PR0202-21	First Aid & Disaster Management	0	2	1	25	25	50	- -
21	25HS02PR0202-22	Basic Nutritional Course	0	2	1	25	25	50	- -
22	25HS02PR0202-23	Stress Management Through Yoga &Meditation	0	2	1	25	25	50	- -

Semester II

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SN	Course Type	Course Code	Course Name	Hours/ week			Credits	Maximum Marks				ESE Duration (Hrs.)
				L	P	S		Cont. Evaluation		End Sem Exam	Total	
								Th	Pr			
1	BSC	25HS03TH0217	Linear Algebra and Integral calculus	3	0	1	3	50	-	50	100	3
2	BSC	25HS05TP0203	Applied Physics	3	2	2	4	50	50	50	150	3
3	ESC	25ES04TH0201	Introduction to Artificial Intelligence	3	0	1	3	50	-	50	100	3
4	ESC	25ES04TH0202	Theory of Mechanisms & Elasticity	3	0	1	3	50	-	50	100	3
5	ESC	25ES04TH0203	Digital Logic Design	2	2	1	3	50	50	50	150	2
6	ESC	25ES04TP0204	Data Structure and OOPS	2	2	2	3	50	50	50	150	2
7	VSEC	25ES04TP0205	Fabrication Practices	1	2	1	2	50	50		100	-
8	CCA	25HS02PR0206-1 to 23	Liberal/Performing Arts Lab	0	2		1	-	25	25	50	-
9	CCA	25HS04PR0201	Sports-Yoga-Recreation	0	2		1		50		50	
TOTAL				**17**	**12**	**8**	**23**	**350**	**275**	**325**	**950**	**16**

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

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Semester III

SN	Course Type	Course Code	Course Name	Hours/Week			Credits	Maximum Marks			Total	ESE Duration (Hrs.)
				L	P	s		Cont. Evaluation		End Sem Exam		
								TH	PR			
1	BSC	25HS04TH0303	Probability & Statistics	3	0	1	3	50	-	50	100	3
2	PCC	25ES04TH0301	Thermodynamics	3	0	1	3	50	-	50	100	3
3	PCC	25ES04TP0302	Manufacturing Engineering	2	2	2	3	50	50	50	150	2
4	PCC	25ES04TP0303	Materials Science & Testing	2	2	2	3	50	50	50	150	2
5	PCC	25ES04TP0304	Introduction to Python	2	2	2	3	50	50	50	150	-
6	PCC	25ES04TP0305	Machine Drawing and CAD	1	2	2	2	50	50	50	150	-
7	OE	25ESOEC03TH0306	Open Elective-I/ MOOC	2	0	2	2	50	-	50	100	2
8	MDM	25ES04TH0307	MDM-I	3	0	1	3	50	-	50	100	3
9	AEC	25HS01TP0301	Environmental Science	1	2	1	2	50	-	-	50	-
			TOTAL	**18**	**10**	**12**	**24**	**400**	**250**	**400**	**1050**	**15**

Semester IV

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SN	Course Type	Course Code	Course Name	Hours/Week			Credits	Maximum Marks			Total	ESE Duration (Hrs.)
				L	P	S		Cont. Evaluation		End Sem Exam		
								TH	PR			
1	PCC	25ES04TH0401	Mechanics of Solids	3	0	1	3	50	-	50	100	3
2	PCC	25ES04TP0402	Kinematics and Dynamics of Machinery	3	2	2	4	50	50	50	150	3
3	PCC	25ES04TP0403	Fluid Mechanics and Hydraulic Machines	3	2	2	4	50	50	50	150	3
4	PCC	25ES04TP0404	Manufacturing Technology	3	2	2	4	50	50	50	150	3
5	CEP/FP	25ES04PR0405	Project-1 (Mini project)	0	2	2	1	-	50	-	50	-
6	OE	25ESOEC04TH0406	Open Elective-II/ MOOC	2	0	2	2	50	-	50	100	2
7	MDM	25ES04TH0407	MDM-II	3	0	1	3	50	-	50	100	3
8	AEC	25ES03AECPR0408	Basic Competitive Coding	0	2	2	1	-	50	-	50	-
9	BSC	25HS04PR0301	Self-Defence & Indian Martial Art									
			TOTAL	**18**	**12**	**14**	**24**	**350**	**250**	**300**	**900**	**17**

***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

Sr. No.	Course Type	Course Code	Course Name	Hours/week			Credits	Maximum marks				ESE Duration (Hrs)
				L	P	S		Continuous Evaluation		End Sem Exam	Total	
1	PCC	25ES04TP0501	Robotics and Mechatronics	2	2	2	3	50	50	50	150	2
2	PCC	25ES04TP0502	Design of Machine Elements	3	2	2	4	50	50	50	150	3
3	PCC	25ES04TP0503	Heat Transfer	3	2	2	4	50	50	50	150	3
4	PCC	25ES04TP0504	Instrumentation and control	3	2	2	4	50	50	50	150	3
5	MDM	25ES04TH0507	MDM-III	3		2	3	50	-	50	100	3
6	PSE	25ESPSE05TH0505	Program Specific Elective-I (List Specified)	3	0	2	3	50	-	50	100	3
7	OE	25ESOEC05TH0506	Open Elective-III OR MOOC Course	3	0	2	3	50	-	50	100	3
			Total	**17**	**8**	**14**	**24**	**350**	**200**	**350**	**900**	**20**

Program Specific Elective-I

Sem	Program elective	**Energy systems**	**Smart Manufacturing/Automation**	**System Engineering & Analytics**	**Robotics & AI**
V	1	Renewable energy system (25ESPSE04TH0505-2)	Additive Manufacturing (25ESPSE04TH0505-3)	Work system design (25ESPSE04TH0505-4)	Fundamentals of Robotics (25ESPSE04TH0505-5)

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Semester VI

Sr. No.	Course Type	Course Code	Course Name	Hours/week			Credits	Maximum marks				ESE Duration (Hrs)
				L	P	S		Continuous Evaluation		End Sem Exam	Total	
1	PCC	25ES04TH0601	Robotic Process Automation	3	0	2	3	50		50	100	3
2	PCC	25ES04TP0602	Computer Aided Engineering	3	2	2	4	50	50	50	150	3
3	PCC	25ES04TH0603	Applied Thermal Engineering	3	2	2	4	50		50	100	3
4	PCC	25ES04TH0604	Creativity Innovation and Design Thinking	3	2	2	4	50	50	50	150	3
5	PSE	25ESPSE04TP0605	Program Specific Elective-II (List specified)	3	0	2	3	50	50	50	150	3
6	MDM	25ES04TH0607	MDM-IV	3	0	0	3	50	-	50	100	3
7	Project	25ES04PR0608	Project-II	0	4	2	2	50		50	100	2
Total				**18**	**10**	**12**	**23**	**350**	**150**	**350**	**850**	**20**

***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 (25ESPSE04TH0606-2)	Geometric Dimensioning & Tolerancing (25ESPSE04TH0606-3)	Facilities Planning and Design (25ESPSE04TH0606-4)	Artificial Intelligence (25ESPSE04TH0606-5)

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

Semester VII

Sr. No.	Course Type	Course Code	Course Name	Hours/week			Credits	Maximum marks				ESE Duration (Hrs)
				L	P	S		Continuous Evaluation		End Sem Exam	Total	
1	PCC	25ES04TP0702	Automation in Manufacturing	2	2	2	3	50	50	50	150	3
2	PSE	25ESPSE04TH0703	Program Specific Elective-III (List specified)	3	0	2	3	50		50	100	3
3	PSE	25ESPSE04TP0704	Program Specific Elective-IV (List specified)	3	0	2	3	50	-	50	150	3
4	Project	25ES04PR0706	Project-III	0	8	2	4	100		100	200	3
5	AEC	University Policy	Participative Learning	-	-	15	1	-	-	-	-	-
Total				**08**	**10**	**23**	**14**	**250**	**50**	**250**	**550**	12

Program Specific Elective- III & IV

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Sem	Program elective	**Energy systems**	**Smart Manufacturing/Automation**	**System Engineering & Analytics**	**Robotics & AI**
VII	3	Energy Management (25ESPSE04TH0702-2)	Internet of Things and Automation (25ESPSE04TH0702-3)	Lean Manufacturing & Value Engineering (25ESPSE04TH0702-4)	Machine Learning (25ESPSE04TH0702-5)
VII	4	Electrical Vehicle Technology (25ESPSE04TH0703-2)	Sustainability and Green Manufacturing (25ESPSE04TH0703-3)	Engg Economics & Cost Control (25ESPSE04TH0703-4)	Mobile Robotics (25ESPSE04TH0703-5)

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Semester VIII

Sr. No.	Course Type	Course Code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
				L	P	S		Continuous Evaluation	End Sem Exam	Total	
1	PSE	25ESPSE04TH0801	Occupational Health & Safety OR MOOC courses	3	0	2	3	50	50	100	3
2	PSE	25ESPSE04TH0802	Multi-criteria Decision Making OR MOOC Courses	3	0	2	3	50	50	100	3
3	Project	25ES04PR0803	Project-IV	0	12	2	6	100	100	200	3
			Total	**6**	**12**	**6**	**12**	**200**	**200**	**400**	**9**
OR											
1	ELC	25ESELC04TH0804	Research Methodology OR Research Paper Publication in WoS/SCOPUS/SCI Journal	4	0	2	4	50	50	100	3
2	ELC	25ESELC04PR0805	Full Semester Research Internship at the Institute	0	16	2	8	150	150	300	-
			Total	**4**	**16**	**4**	**12**	**200**	**200**	**400**	**3**
OR											
1	ELC	25ESELC04PR0807	Full Semester Industry Internship	0	24	2	12	200	200	400	-
					24	4	12			400	

Programme Specific Electives

Sem	Program elective	**Energy systems#**	**Smart Manufacturing/Automation**	**System Engineering & Analytics**	**Robotics & AI**
V	1	Renewable energy system (25ESPSE04TH0505-1)	Additive Manufacturing (25ESPSE04TH0505-2)	Work system design (25ESPSE04TH0505-3)	Fundamentals of Robotics (25ESPSE04TH0505-4)
VI	2	Battery Technology and Energy Storage Systems (25ESPSE04TH0606-1)	Geometric Dimensioning & Tolerancing (25ESPSE04TH0606-2)	Facilities Planning and Design (25ESPSE04TH0606-3)	Artificial Intelligence (25ESPSE04TH0606-4)
VII	3	Energy Management (25ESPSE04TH0702-1)	Internet of Things and Automation (25ESPSE04TH0702-2)	Lean Manufacturing & Value Engineering (25ESPSE04TH0702-3)	Machine Learning (25ESPSE04TH0702-4)
VII	4	Electrical Vehicle Technology (25ESPSE04TH0703-1)	Sustainability and Green Manufacturing (25ESPSE04TH0703-2)	Engg Economics & Cost Control (25ESPSE04TH0703-3)	Mobile Robotics (25ESPSE04TH0703-4)

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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	25ES03PR0709	Industry Internship Phase-I			12				350	
2	MOOC	25ES03PR0710	MOOC-I			3				175	3
3	MOOC	25ES03PR0711	MOOC-II			3				175	3
Total						**18**					**6**
One Year Internship Phase-II											
1	Internship	25ES03PR0807	Industry Internship Phase-II			12				**350**	

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	20	600	300	900	6	15	17	5
II	16	12	23	625	225	850	4	12	16	6
III	18	08	24	550	300	850	5	13	18	4
IV	17	12	24	550	300	850	5	15	17	5
V	17	10	24	650	300	950	5	14	17	5
VI	15	14	23	500	300	800	5	15	15	7
VII	11	12	23	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	25ESOE04TH0306	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	25ESOE04TH0406	Six Sigma Principles (13 Hour) Supply Chain Management and Analytics (34 Hour)	2	0	2	50	50	100	2
3	V	25ESOE04TH0506	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

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	25ES04HT0301	Geometric Dimensioning and Tolerances	3	0	2	3	50	50	100	3
2	IV	25ES04HT0401	Advanced Solid Modelling & Assembly	3	0	2	3	50	50	100	3
3	V	25ES04HT0501	Additive Manufacturing Techniques	4	0	2	4	50	50	100	3
4	VI	25ES04HT0601	Design for Manufacturing	4	0	2	4	50	50	100	3
5	VII	25ES04HP0701	Project	0	8	2	4	50	50	100	3
			TOTAL	**14**	**8**	**10**	**18**	**250**	**250**	**500**	**15**

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

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Minors Scheme

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	25ES04MT0301	Basics of Mechanical Engineering	3	0	2	3	50	50	100	3
2	IV	25ES04MT0401	Energy system and technologies	3	0	2	3	50	50	100	3
3	V	25ES04MT0501	Product Design & Digital Manufacturing	4	0	2	4	50	50	100	3
4	VI	25ES04MT0601	Automotive Technology	4	0	2	4	50	50	100	3
5	VII	25ES04MP0701	Project	0	8	2	4	50	50	100	3
			TOTAL	**14**	**8**	**10**	**18**	**250**	**250**	500	15

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MDM- Defense Technology											
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	25ES03TH0307	Défense Platforms	3	0	2	3	50	50	100	3
2	IV	25ES03TH0407	Warfare system	3	0	2	3	50	50	100	3
3	V	25ES03TH0507	Weapon Systems	3	0	2	3	50	50	100	3
4	VI	25ES03TH0607	Self-defence & Protection system	3	0	2	3	50	50	100	3
			TOTAL	**12**	**0**	**8**	**12**				

B.Tech. Mechanical Engineering

Programme Syllabus

Semester-I

Course Code	Course Title				Category
25HS03TP0107	Differential Calculus and Basics of Statistics				BSC
Contact Hours per Week			CA	FE	Credits
L	P	S			
3	2	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).

Course Code	Course Title				Category
25EE07TP0106	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.

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering
Session: 2025-26

Course Code	Course Title				Category
25ES04TH0101	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

Course Code	Course Title				Category
25ES04TP0102	**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: 25ES04TP0102

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
25ES04TP0103	**Programming for problem Solving**				**ESC**
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
2	**2**	**1**	**50**	**50**	**03**

Prerequisite:

Course Objectives:

After completing this course, students will be able to:

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

Course Outcomes:

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

CO1: Apply and Implement Fundamental Programming Constructs.
CO2: Analyze and Design Solutions Using Advanced Data Structures.
CO3: Evaluate and Optimize Program Performance Through Algorithmic Techniques.
CO4: Design and Develop Object-Oriented Solutions Using C++.
CO5: Design and Develop concepts to solve real-world coding problems.

UNIT I: Fundamentals of C Programming — **10 Hours**

1.1 Introduction to Programming and C Language: 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: 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: 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: 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 II: Functions and Storage Classes — **10 Hours**

2.1 Functions: 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: Concept of recursion, Recursive vs. iterative approach, Applications: factorial, Fibonacci series, Tower of Hanoi, Advantages and limitations of recursion

2.3 Storage Classes: Automatic (auto) storage class, External (extern) storage class, Static storage class, Register storage class, Scope and lifetime of variables

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

UNIT III: Advanced Topics — **10 Hours**

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

3.2 Strings: String declaration and initialization, String input/output functions, String manipulation functions: strlen(), strcpy(), strcat(), strcmp(), Array of strings
3.3 Pointers: 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: Introduction to structures, Structure declaration and initialization, Accessing structure members, Array of structures, Structures and functions, Nested structures, Pointers to structures

UNIT IV: Introduction to C++ and Object-Oriented Programming	**9 Hours**

4.1 Basics of C++: 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: 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: Concept of operator overloading, Overloading unary operators, Overloading binary operators, Rules and restrictions for operator overloading, Type conversion in C++
4.4 Inheritance: 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 V: 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.

Textbooks for C Programming:

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.

Textbooks for C++ Programming:

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 Code	Course Title				Category
25ES03TP0103	**Programming for problem Solving - 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.

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

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

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

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

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

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

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

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

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

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

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

Ramdeobaba University, Nagpur

Department of Mechanical Engineering

Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering

Session: 2025-26

Course Code	Course Title				Category
25HS02TP0101	English for Professional communication				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, 2025

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
25HS02TH0104	**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.

B.Tech. in Mechanical Engineering
Programme Syllabus
Semester-II

Course Code	Course Title				Category
25HS03TH0217	**Linear Algebra and Integral Calculus**				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
25HS05TP0203	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.
6. 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
25ES04TH0201*	**Introduction to Artificial Intelligence**	**ESC**

Contact Hours per Week			CA	FE	Credits
L	**P**	**S**			
3	0	1	50	50	3

**Note: Table lists code 25ES04TH0201 for this course; the syllabus section of the document uses this same code for 'Theory of Mechanisms & Elasticity'. This is a discrepancy in the source scheme and should be verified with the Department.*

Prerequisite: Basic knowledge of mathematics and programming.

Course Objectives:

1. To introduce students to the fundamental concepts and history of Artificial Intelligence.
2. To familiarise students with problem solving, search and knowledge representation techniques.
3. To introduce basic machine learning concepts relevant to engineering applications.

Course Outcomes:

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

1. CO1: Explain the foundations, history and applications of Artificial Intelligence.
2. CO2: Formulate engineering problems as state-space search problems and apply search algorithms.
3. CO3: Represent knowledge using logic-based and rule-based systems.
4. CO4: Describe fundamentals of machine learning and its use in intelligent systems.
5. CO5: Apply basic AI techniques to simple mechanical/robotic problem scenarios.

UNIT I: Introduction to AI 6 Hours

History and foundations of AI, intelligent agents, agent environments, applications of AI in engineering.

UNIT II: Problem Solving by Search 7 Hours

State space representation, uninformed search (BFS, DFS), informed search (A*, greedy), heuristics.

UNIT III: Knowledge Representation and Reasoning 7 Hours

Propositional and predicate logic, rule-based systems, semantic networks, production systems.

UNIT IV: Introduction to Machine Learning 7 Hours

Supervised vs unsupervised learning, basic regression and classification concepts, overview of neural networks.

UNIT V: AI Applications in Engineering 5 Hours

AI in robotics, manufacturing, predictive maintenance; introduction to AI toolkits.

Textbooks:

1. Russell, S., Norvig, P. Artificial Intelligence: A Modern Approach. Pearson.
2. Khemani, D. A First Course in Artificial Intelligence. McGraw Hill.

Reference Books:

1. Rich, E., Knight, K. Artificial Intelligence. Tata McGraw Hill.
2. Rothman, D. Artificial

Course Code	Course Title				Category
25ES04TH0201	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
25ES04TH0203	Digital Logic Design	ESC

Contact Hours per Week			CA	FE	Credits
L	P	S			
2	2	1	50	50	3

Prerequisite: Basic knowledge of mathematics and Boolean algebra.

Course Objectives:

1. To introduce number systems and Boolean algebra as applied to digital circuits.
2. To familiarise students with combinational and sequential logic circuit design.
3. To develop practical skills in designing and simulating basic digital circuits.

Course Outcomes:

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

1. CO1: Convert between number systems and simplify Boolean expressions using algebra and K-maps.
2. CO2: Design and analyse combinational logic circuits.
3. CO3: Design and analyse sequential logic circuits using flip-flops.
4. CO4: Design counters and registers for engineering applications.
5. CO5: Simulate and verify basic digital circuits using simulation tools.

UNIT I: Number Systems and Boolean Algebra 7 Hours

Number systems and conversions, binary arithmetic, Boolean algebra, logic gates, K-map simplification.

UNIT II: Combinational Circuits 7 Hours

Adders, subtractors, multiplexers, demultiplexers, encoders, decoders, comparators.

UNIT III: Sequential Circuits - I 7 Hours

Latches and flip-flops (SR, JK, D, T), excitation tables, flip-flop conversions.

UNIT IV: Sequential Circuits - II 7 Hours

Registers, shift registers, synchronous and asynchronous counters, design of counters.

UNIT V: Introduction to Programmable Logic 4 Hours

Overview of PLDs, basics of memory devices, introduction to HDL-based design.

List of Experiments:

1. Verification of logic gates and Boolean laws.
2. Design and implementation of half/full adder and subtractor.
3. Design of multiplexer/demultiplexer circuits.

4. Design of encoder/decoder circuits.
5. Study and verification of SR, JK, D and T flip-flops.
6. Design of a synchronous counter.
7. Design of a shift register.
8. Simulation of a combinational circuit using simulation software.

Textbooks:

1. Morris Mano, M. Digital Logic and Computer Design. Pearson.
2. Floyd, T.L. Digital Fundamentals. Pearson.

Reference Books:

1. Malvino, A.P., Leach, D. Digital Principles and Applications. McGraw Hill.

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering
Session: 2025-26

Course Code			Course Title		Category
25ES04TP0204			**Data Structures and OOPS**		Professional Core
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
02	02	02	100	50	03

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 and OOPS 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.

Ramdeobaba University, Nagpur

Department of Mechanical Engineering

Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering

Session: 2025-26

Course Code	Course Title				Category
25ES04TP0204	**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
25HS02PR0105-1	**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
25HS02PR0105-2	**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**
25HS02PR0105-3	**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
25HS02PR0105-8	**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
25HS02PR0105-9	**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
25HS02PR0105-10	**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
25HS02PR0105-11	**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

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Course Code	Course Title				Category
25HS02PR0105-12	**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.

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Course Code	Course Title				Category
25HS02PR0105-13	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
25HS02PR0105-14	**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

Course Code	Course Title				Category
25HS02PR0105-1-1	**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
25HS02PR0105-1-1	**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
25HS02PR0105-1-1	**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)

Course Code	Course Title	Category
25HS04PR0201	Sports - Yoga - Recreation	CCA

Contact Hours per Week			CA	FE	Credits
L	P	S			
0	2	1	50	0	1

Prerequisite: None.

Course Objectives:

1. To promote physical fitness and holistic well-being through sports, yoga and recreational activities.
2. To develop teamwork, discipline and stress-management skills.

Course Outcomes:

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

1. CO1: Participate actively in selected sports/recreational activities.
2. CO2: Demonstrate basic yoga asanas and breathing techniques.
3. CO3: Exhibit improved physical fitness and coordination.
4. CO4: Apply principles of teamwork and sportsmanship.

UNIT I: Orientation and Fitness Assessment 2 Hours

Introduction to CCA activities, baseline fitness assessment.

UNIT II: Sports Practice 5 Hours

Practice sessions in selected sport (athletics/team games) with basic skill drills.

UNIT III: Yoga Practice 5 Hours

Basic asanas, pranayama and relaxation techniques.

UNIT IV: Recreational Activities 4 Hours

Group recreational games, indoor/outdoor activities.

UNIT V: Assessment 2 Hours

Fitness re-assessment and participation evaluation.

Textbooks:

1. Departmental activity handbook / NSO guidelines.

Reference Books:

1. Iyengar, B.K.S. Light on Yoga.

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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.

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 fluid. Determination of dryness fraction using various calorimeters	9 Hrs.
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**
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**				PCC
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	**9 Hrs.**

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.	
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**
26ES04TP0202	**Machine Drawing and CAD Sem-III**					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 & CAD Lab Sem-III**			PCC
Contact Hours per Week		**CA**	**ESE**	**Credits**

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering
Session: 2025-26

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**
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

Syllabus V SEMESTER

Robotics and Mechatronics

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
25ES04TP0501	Robotics and Mechatronics	PCC	02-02-02	50	50	03

Prerequisite: Theory of Machines, Basic Electronics, Basics of Programming.

Course Objectives:

The objectives of this course are: To enable students to understand the fundamentals of robotics and mechatronic systems, including sensors, actuators, control and integration, for design and automation applications.

Course Outcomes

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

CO1: Explain the basic concepts, classification and applications of robots and mechatronic systems.

CO2: Analyze the kinematics of robot manipulators using coordinate transformations.

CO3: Describe the working of sensors and actuators used in robotic and mechatronic systems.

CO4: Explain robot control systems and programming methods.

CO5: Apply mechatronic system design principles for integration of mechanical, electrical and control elements.

UNIT I: INTRODUCTION TO ROBOTICS AND MECHATRONICS **06 Hrs.**

Definition and classification of robots, robot anatomy and specifications, applications of robots in industry, introduction to mechatronics, mechatronic system design approach, elements of a mechatronic system.

UNIT II: ROBOT KINEMATICS **08 Hrs.**

Coordinate systems and transformations, homogeneous transformation matrices, forward kinematics of robot manipulators, basic concept of inverse kinematics, degrees of freedom and robot configurations.

UNIT III: SENSORS AND ACTUATORS **08 Hrs.**

Classification of sensors: position, velocity, force and proximity sensors, actuators: pneumatic, hydraulic and electric actuators, basic principle of stepper motors and servo motors, overview of sensor interfacing.

UNIT IV: ROBOT CONTROL AND PROGRAMMING **09 Hrs.**

Robot control systems: point-to-point and continuous path control, robot programming methods: teach pendant and offline programming, introduction to robot programming languages, basic robot end effectors and grippers.

UNIT V: MECHATRONIC SYSTEM DESIGN **08 Hrs.**

Mechatronic design process, basic concept of microcontroller-based control systems, integration of mechanical, electrical and software elements, case studies of mechatronic systems in industry.

List of Experiments:

1. Study of robot anatomy, specifications and work envelope of an industrial robot.
2. Forward kinematics analysis of a robot manipulator using simulation software.
3. Inverse kinematics analysis of a robot manipulator using simulation software.
4. Study and interfacing of proximity and position sensors with a microcontroller.
5. Study of pneumatic and electric actuators used in robotic systems.
6. Programming and operation of a robot for a pick-and-place application.
7. Trajectory planning and simulation of a robot manipulator.
8. Design and simulation of a simple mechatronic system integrating a sensor, actuator and controller.

TEXT BOOKS:

1. S. K. Saha, Introduction to Robotics, 2nd Edition, McGraw Hill Education, 2014.
2. W. Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, 6th Edition, Pearson Education, 2015.
3. R. K. Mittal and I. J. Nagrath, Robotics and Control, McGraw Hill Education, 2003.

REFERENCE BOOKS:

1. John J. Craig, Introduction to Robotics: Mechanics and Control, 3rd Edition, Pearson Education, 2005.
2. Devdas Shetty and Richard A. Kolk, Mechatronics System Design, 2nd Edition, Cengage Learning, 2010.
3. Saeed B. Niku, Introduction to Robotics: Analysis, Control, Applications, 3rd Edition, Wiley, 2020.

Design of Machine Elements

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
25ES04TP0502	Design of Machine Elements	PCC	03-02-02	50	50	04

Prerequisite: Strength of Materials, Engineering Drawing / Machine Drawing.

Course Objectives:

The objectives of this course are: To enable students to apply design principles and standards for the design of common machine elements used in mechanical systems.

Course Outcomes

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

CO1: Explain the design procedure, standards and material selection for machine elements.

CO2: Design machine elements subjected to static and variable loading.

CO3: Design shafts, keys and couplings for power transmission.

CO4: Design mechanical joints including riveted, welded and threaded joints.

CO5: Design power transmission elements such as springs and belts/chains.

UNIT I: FUNDAMENTALS OF MACHINE DESIGN **06 Hrs.**

Design process, factor of safety, design standards and codes, material selection for machine elements, preferred numbers, manufacturing considerations in design.

UNIT II: DESIGN FOR STATIC AND VARIABLE LOADING **08 Hrs.**

Design for static loading: theories of failure, design for variable loading: fatigue, endurance limit and the S-N curve, factors affecting endurance strength, basic concept of stress concentration.

UNIT III: DESIGN OF SHAFTS, KEYS AND COUPLINGS **08 Hrs.**

Design of shafts subjected to combined bending and torsion, ASME code for shaft design, design of keys, design of rigid and flexible couplings.

UNIT IV: DESIGN OF JOINTS **09 Hrs.**

Design of riveted joints, design of welded joints, design of threaded fasteners and bolted joints, basic concept of eccentrically loaded joints.

UNIT V: DESIGN OF SPRINGS AND POWER TRANSMISSION ELEMENTS **08 Hrs.**

Design of helical compression and tension springs, basic concept of leaf spring design, design of belt drives, overview of chain drive design.

List of Experiments:

1. Design and drawing of a rigid flange coupling.
2. Design and drawing of a flexible bush-pin coupling.
3. Design and drawing of a knuckle joint.
4. Design of a shaft subjected to combined bending and torsion.
5. Design of a riveted joint for a given loading condition.
6. Design of a welded joint for a given loading condition.
7. Design of a helical compression spring.
8. Design of a belt drive for a given power transmission application.

TEXT BOOKS:

1. V. B. Bhandari, Design of Machine Elements, 4th Edition, McGraw Hill Education, 2016.
2. R. S. Khurmi and J. K. Gupta, Machine Design, 14th Edition, S. Chand Publishing, 2005.
3. Richard G. Budynas and J. Keith Nisbett, Shigley's Mechanical Engineering Design, 10th Edition, McGraw Hill Education, 2015.

REFERENCE BOOKS:

1. P. C. Sharma and D. K. Aggarwal, Machine Design, 14th Edition, S. K. Kataria & Sons, 2013.
2. B. D. Shiwalkar, Design of Machine Elements, Denett & Co., 2016.
3. M. F. Spotts, T. E. Shoup and L. E. Hornberger, Design of Machine Elements, 8th Edition, Pearson Education, 2003.

Heat Transfer

Course Code	Course Title	Category	L-P-S	CA	FE	Credits

25ES04TP0503	Heat Transfer	PCC	03-02-02	50	50	04

Prerequisite: Engineering Thermodynamics, Fluid Mechanics.

Course Objectives:

The objectives of this course are: To enable students to understand the principles of conduction, convection and radiation heat transfer and to apply them to the design and analysis of thermal engineering systems.

Course Outcomes

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

CO1: Explain the basic modes of heat transfer and apply Fourier's law to conduction problems.

CO2: Analyze conduction heat transfer through extended surfaces and under unsteady state conditions.

CO3: Analyze forced and free convection heat transfer.

CO4: Apply principles of radiation heat transfer between surfaces.

CO5: Design and analyze heat exchangers for engineering applications.

UNIT I: CONDUCTION HEAT TRANSFER **06 Hrs.**

Modes of heat transfer, Fourier's law of conduction, one-dimensional steady state conduction through plane and composite walls, cylinders and spheres, basic concept of thermal contact resistance.

UNIT II: EXTENDED SURFACES AND UNSTEADY STATE CONDUCTION **08 Hrs.**

Heat transfer through fins: types and performance, fin efficiency and effectiveness, unsteady state conduction: lumped capacitance method, basic use of Heisler charts.

UNIT III: CONVECTION HEAT TRANSFER **08 Hrs.**

Basic concepts of convection, dimensionless numbers in convection, forced convection: overview of flow over a flat plate and inside tubes, free convection: basic concepts and correlations.

UNIT IV: RADIATION HEAT TRANSFER **09 Hrs.**

Basic laws of radiation: Planck's law, Stefan-Boltzmann law and Kirchhoff's law, black body and grey body radiation, basic concept of view factor, radiation heat exchange between surfaces.

UNIT V: HEAT EXCHANGERS **08 Hrs.**

Types of heat exchangers, overall heat transfer coefficient, LMTD method, effectiveness-NTU method, basic concept of fouling factor, applications of heat exchangers in industry.

List of Experiments:

1. Determination of thermal conductivity of a metal rod.
2. Determination of thermal conductivity of an insulating material.
3. Study of heat transfer through a pin-fin apparatus.
4. Determination of heat transfer coefficient in natural convection.
5. Determination of heat transfer coefficient in forced convection.
6. Determination of emissivity of a test surface.
7. Study of the Stefan-Boltzmann apparatus for radiation heat transfer.
8. Performance test on a parallel flow and counter flow heat exchanger.

TEXT BOOKS:

1. P. K. Nag, Heat and Mass Transfer, 5th Edition, McGraw Hill Education, 2019.
2. R. C. Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, 5th Edition, New Age International, 2017.
3. Frank P. Incropera and David P. DeWitt, Fundamentals of Heat and Mass Transfer, 7th Edition, Wiley, 2011.

REFERENCE BOOKS:

1. J. P. Holman, Heat Transfer, 10th Edition, McGraw Hill Education, 2009.
2. Yunus A. Cengel, Heat and Mass Transfer, 5th Edition, McGraw Hill Education, 2015.
3. S. P. Sukhatme, A Textbook on Heat Transfer, 4th Edition, Universities Press, 2005.

Instrumentation and Control

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
25ES04TP0504	Instrumentation and Control	PCC	03-02-02	50	50	04

Prerequisite: Basic Electrical and Electronics Engineering, Engineering Mathematics.

Course Objectives:

The objectives of this course are: To enable students to understand the principles of measurement systems, sensors/transducers and control systems for engineering applications.

Course Outcomes

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

CO1: Explain the basic elements and characteristics of a measurement system.

CO2: Describe the working principles of transducers used for measurement of mechanical quantities.

CO3: Analyze the mathematical modeling and transfer function representation of control systems.

CO4: Analyze the time domain and frequency domain response of control systems.

CO5: Apply stability analysis techniques for control systems.

UNIT I: FUNDAMENTALS OF MEASUREMENT SYSTEMS **06 Hrs.**

Elements of a generalized measurement system, static and dynamic characteristics of instruments, errors in measurement, basic concept of calibration, classification of transducers.

UNIT II: TRANSDUCERS FOR MECHANICAL MEASUREMENTS **08 Hrs.**

Transducers for displacement, velocity and acceleration measurement, strain gauges and load cells, overview of transducers for pressure, temperature and flow measurement.

UNIT III: MATHEMATICAL MODELING OF CONTROL SYSTEMS **08 Hrs.**

Concept of open loop and closed loop control systems, mathematical modeling of mechanical and electrical systems, transfer function representation, block diagram reduction, basic concept of signal flow graphs.

UNIT IV: TIME AND FREQUENCY RESPONSE ANALYSIS **09 Hrs.**

Time response of first and second order systems, time domain specifications, steady state error analysis, basic concept of frequency response and the Bode plot.

UNIT V: STABILITY ANALYSIS OF CONTROL SYSTEMS **08 Hrs.**

Concept of stability, Routh-Hurwitz stability criterion, basic concept of the root locus technique, introduction to PID controllers and their application in control systems.

List of Experiments:

1. Calibration of a pressure gauge using a dead weight tester.
2. Measurement of displacement using an LVDT.
3. Measurement of strain using a strain gauge and study of a load cell.
4. Measurement of temperature using a thermocouple and an RTD.
5. Study of the time response of a first order system.
6. Study of the time response of a second order system.
7. Study of a PID controller for a process control application.
8. Determination of stability of a control system using the Routh-Hurwitz criterion (simulation-based).

TEXT BOOKS:

1. D. S. Kumar, Mechanical Measurements and Control, 6th Edition, Metropolitan Book Co., 2015.
2. Nakra and Chaudhry, Instrumentation, Measurement and Analysis, 3rd Edition, McGraw Hill Education, 2009.
3. I. J. Nagrath and M. Gopal, Control Systems Engineering, 6th Edition, New Age International, 2017.

REFERENCE BOOKS:

1. Ernest O. Doebelin, Measurement Systems: Application and Design, 5th Edition, McGraw Hill Education, 2007.
2. Katsuhiko Ogata, Modern Control Engineering, 5th Edition, Pearson Education, 2010.
3. A. K. Sawhney, A Course in Electrical and Electronic Measurements and Instrumentation, 19th Edition, Dhanpat Rai & Co., 2015.

VI SEMESTER SYLLABUS

Robotic Process Automation

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
25ES04TH0601	Robotic Process Automation	PCC	03-00-02	50	50	03

Prerequisite: Basics of Programming, Basics of Computer Applications.

Course Objectives:

The objectives of this course are: To enable students to understand the concepts, tools and applications of Robotic Process Automation (RPA) for automating repetitive business and engineering processes.

Course Outcomes

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

CO1: Explain the basic concepts, benefits and applications of Robotic Process Automation.

CO2: Describe the RPA life cycle and RPA development methodology.

CO3: Analyze process identification and process design techniques for RPA implementation.

CO4: Apply RPA tools for bot development and automation of simple processes.

CO5: Evaluate RPA governance, security and future trends including AI-integrated automation.

UNIT I: INTRODUCTION TO ROBOTIC PROCESS AUTOMATION **06 Hrs.**

Definition and scope of RPA, evolution of automation technologies, benefits and limitations of RPA, difference between RPA and traditional automation, applications of RPA in industry.

UNIT II: RPA LIFE CYCLE AND METHODOLOGY **08 Hrs.**

RPA project life cycle: discovery, solution design, development, testing and deployment, RPA development methodologies, roles in an RPA project, basic concept of an RPA center of excellence.

UNIT III: PROCESS IDENTIFICATION AND DESIGN **08 Hrs.**

Criteria for process selection for automation, process mapping techniques, overview of the process design document (PDD) and solution design document (SDD), exception handling in process design.

UNIT IV: RPA TOOLS AND BOT DEVELOPMENT **09 Hrs.**

Overview of RPA tools (UiPath / Automation Anywhere / Blue Prism), bot development basics: recording, workflow design and control flow, basics of data manipulation and screen scraping.

UNIT V: RPA GOVERNANCE, SECURITY AND FUTURE TRENDS **08 Hrs.**

RPA governance framework, security considerations in RPA, basic concept of bot deployment and monitoring, overview of integration of RPA with artificial intelligence (Intelligent Automation), future trends in automation.

TEXT BOOKS:

1. Alok Mani Tripathi, Learning Robotic Process Automation, Packt Publishing, 2018.

2. Lasse Rouhiainen, Robotic Process Automation with Automation Anywhere, Independently Published, 2019.

3. Tom Taulli, The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems, Apress, 2020.

REFERENCE BOOKS:

1. Richard Murdoch, Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks and Become an RPA Consultant, Independently Published, 2018.

2. Srikanth Merianda, Robotic Process Automation Tools, Process Automation and Their Benefits, Chetu Inc., 2018.

3. UiPath Documentation and Academy Learning Resources, UiPath Inc.

Computer Aided Engineering

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
25ES04TP0602	Computer Aided Engineering	PCC	03-02-02	50	50	04

Prerequisite: Strength of Materials, Computer Aided Design, Engineering Mathematics.

Course Objectives:

The objectives of this course are: To enable students to understand the fundamentals of finite element analysis and to apply computer aided engineering tools for structural, thermal and modal analysis of mechanical components.

Course Outcomes

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

CO1: Explain the basic concepts and steps involved in finite element analysis.

CO2: Formulate finite element equations for one-dimensional and two-dimensional elements.

CO3: Apply CAE software for structural (static) analysis of mechanical components.

CO4: Apply CAE software for thermal and modal analysis of mechanical components.

CO5: Interpret and validate CAE simulation results for engineering design applications.

UNIT I: INTRODUCTION TO FINITE ELEMENT ANALYSIS **06 Hrs.**

Basic concept of the finite element method, general steps in FEA, discretization of a domain, types of elements, basic concept of shape functions, applications of FEA in mechanical engineering.

UNIT II: FINITE ELEMENT FORMULATION **08 Hrs.**

Stiffness matrix formulation for bar and truss elements, basic concept of beam elements, overview of formulation for two-dimensional elements (CST), assembly of element equations, boundary conditions.

UNIT III: STRUCTURAL ANALYSIS USING CAE SOFTWARE **08 Hrs.**

Pre-processing: geometry cleanup, meshing techniques and mesh quality, material properties and boundary conditions, static structural analysis of simple components using CAE software, post-processing of results.

UNIT IV: THERMAL AND MODAL ANALYSIS USING CAE SOFTWARE **09 Hrs.**

Basics of steady state and transient thermal analysis using CAE software, basics of modal analysis: natural frequencies and mode shapes, basic concept of coupled thermal-structural analysis.

UNIT V: RESULT INTERPRETATION AND VALIDATION **08 Hrs.**

Convergence study, mesh sensitivity analysis, validation of FEA results with analytical/experimental data, basic concept of error estimation, case studies of CAE application in mechanical component design.

List of Experiments:

1. Introduction to CAE software interface and basic workflow.
2. Static structural analysis of a cantilever beam.
3. Static structural analysis of a plate with a hole (stress concentration study).
4. Meshing and mesh convergence study of a mechanical component.
5. Static structural analysis of a bracket/component subjected to combined loading.
6. Steady state thermal analysis of a simple component.
7. Modal analysis of a cantilever beam to determine natural frequencies.
8. Validation of CAE results with analytical calculations for a standard case.

TEXT BOOKS:

1. Tirupathi R. Chandrupatla and Ashok D. Belegundu, Introduction to Finite Elements in Engineering, 4th Edition, Pearson Education, 2011.
2. Robert D. Cook, David S. Malkus and Michael E. Plesha, Concepts and Applications of Finite Element Analysis, 4th Edition, Wiley, 2001.
3. Sham Tickoo, ANSYS Workbench for Engineers and Designers, CADCIM Technologies, 2020.

REFERENCE BOOKS:

1. Daryl L. Logan, A First Course in the Finite Element Method, 6th Edition, Cengage Learning, 2016.
2. J. N. Reddy, An Introduction to the Finite Element Method, 3rd Edition, McGraw Hill Education, 2005.
3. P. Seshu, Textbook of Finite Element Analysis, PHI Learning, 2003.

Applied Thermal Engineering

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
25ES04TH0603	Applied Thermal Engineering	PCC	03-02-02	50	50	04

Prerequisite: Engineering Thermodynamics, Heat Transfer.

Course Objectives:

The objectives of this course are: To enable students to understand the working principles and applications of thermal engineering systems including IC engines, refrigeration, air conditioning and power plant equipment.

Course Outcomes

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

CO1: Explain the working principles and performance parameters of internal combustion engines.

CO2: Analyze air-standard cycles used in IC engines and gas turbines.

CO3: Explain the principles of refrigeration and analyze vapor compression refrigeration systems.

CO4: Analyze psychrometric processes and air conditioning system design.

CO5: Describe the working of steam power plant equipment and their applications.

UNIT I: INTERNAL COMBUSTION ENGINES **06 Hrs.**

Classification and working of IC engines, engine components, valve timing diagrams, performance parameters: IP, BP, mechanical efficiency and specific fuel consumption, basic concept of testing of IC engines.

UNIT II: AIR STANDARD CYCLES **08 Hrs.**

Otto cycle, Diesel cycle and Dual cycle: analysis and comparison, Brayton cycle for gas turbines, basic concept of actual versus air-standard cycle efficiency.

UNIT III: REFRIGERATION SYSTEMS **08 Hrs.**

Basics of refrigeration, vapor compression refrigeration cycle: analysis and COP calculation, overview of refrigerants and their properties, basic concept of the vapor absorption refrigeration system.

UNIT IV: AIR CONDITIONING SYSTEMS **09 Hrs.**

Psychrometric properties and processes, basic use of the psychrometric chart, basic concept of comfort air conditioning, overview of summer and winter air conditioning systems, basic concept of cooling load estimation.

UNIT V: STEAM POWER PLANT EQUIPMENT **08 Hrs.**

Boilers: classification and working, steam turbines: classification and working, basic concept of condensers and cooling towers, layout of a modern steam power plant.

List of Experiments:

1. Performance test on a four-stroke petrol/diesel engine.
2. Morse test on a multi-cylinder engine (demonstration).
3. Study of the valve timing diagram of an IC engine.
4. Performance test on a vapor compression refrigeration test rig.
5. Study of psychrometric processes using an air conditioning test rig.
6. Study of boiler mountings and accessories.
7. Study of a steam turbine model/cut section.
8. Determination of COP of a domestic refrigerator/window air conditioner.

TEXT BOOKS:

1. R. K. Rajput, Thermal Engineering, 10th Edition, Laxmi Publications, 2019.
2. P. K. Nag, Engineering Thermodynamics, 6th Edition, McGraw Hill Education, 2017.
3. C. P. Arora, Refrigeration and Air Conditioning, 3rd Edition, McGraw Hill Education, 2010.

REFERENCE BOOKS:

1. V. Ganesan, Internal Combustion Engines, 4th Edition, McGraw Hill Education, 2012.
2. R. S. Khurmi and J. K. Gupta, A Textbook of Refrigeration and Air Conditioning, 2nd Edition, S. Chand Publishing, 2012.
3. G. D. Rai, Non-Conventional Energy Sources, 5th Edition, Khanna Publishers, 2011.

Creativity Innovation and Design Thinking

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
25ES04TH0604	Creativity Innovation and Design Thinking	PCC	03-02-02	50	50	04

Prerequisite: Nil.

Course Objectives:

The objectives of this course are: To enable students to develop creative thinking abilities and apply design thinking methodology for innovative problem-solving in engineering.

Course Outcomes

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

CO1: Explain the concepts of creativity, innovation and their importance in engineering practice.

CO2: Apply creative thinking techniques for idea generation and problem-solving.

CO3: Apply the design thinking methodology stages: empathize, define and ideate.

CO4: Apply the design thinking methodology stages: prototype and test.

CO5: Develop an innovative solution/prototype for a real-life engineering problem using design thinking.

UNIT I: FOUNDATIONS OF CREATIVITY AND INNOVATION **06 Hrs.**

Concept of creativity and innovation, types of innovation, myths about creativity, the creative thinking process, barriers to creativity, importance of creativity and innovation in engineering.

UNIT II: CREATIVE THINKING TECHNIQUES **08 Hrs.**

Divergent and convergent thinking, brainstorming and its variants, mind mapping, the SCAMPER technique, basic concept of lateral thinking, overview of TRIZ.

UNIT III: DESIGN THINKING - EMPATHIZE, DEFINE AND IDEATE **08 Hrs.**

Introduction to design thinking, empathy mapping and user research techniques, problem definition and point-of-view statements, ideation techniques for design thinking.

UNIT IV: DESIGN THINKING - PROTOTYPE AND TEST **09 Hrs.**

Prototyping methods: low-fidelity and high-fidelity prototypes, basic concept of rapid prototyping tools, user testing and feedback, iteration in the design thinking process.

UNIT V: INNOVATION PROJECT APPLICATION **08 Hrs.**

Application of design thinking to a real-life engineering problem, team-based innovation project, pitching and presenting innovative solutions, case studies of successful design-thinking-driven innovations.

List of Experiments:

1. Creative thinking exercises: brainstorming and mind mapping on a given problem.
2. Application of the SCAMPER technique to redesign an existing product.
3. Empathy mapping and user interview exercise for a chosen problem.
4. Problem definition and point-of-view statement development.
5. Ideation workshop: generating multiple solution concepts for a problem.
6. Development of a low-fidelity prototype for a selected idea.
7. User testing of the prototype and feedback collection.
8. Final presentation/pitch of the innovative solution developed.

TEXT BOOKS:

1. Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, Harper Business, 2009.
2. Vijay Kumar, 101 Design Methods: A Structured Approach for Driving Innovation in Your Organization, Wiley, 2012.
3. Roger L. Martin, The Design of Business: Why Design Thinking is the Next Competitive Advantage, Harvard Business Review Press, 2009.

REFERENCE BOOKS:

1. Jeanne Liedtka and Tim Ogilvie, Designing for Growth: A Design Thinking Tool Kit for Managers, Columbia University Press, 2011.
2. Michael Michalko, Thinkertoys: A Handbook of Creative-Thinking Techniques, 2nd Edition, Ten Speed Press, 2006.
3. Idris Mootee, Design Thinking for Strategic Innovation, Wiley, 2013.

VII SEMESTER SYLLABUS

Automation in Manufacturing

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
25ES04TP0702	Automation in Manufacturing	PCC	02-02-02	50	50	03

Prerequisite: Manufacturing Processes, Basic Electronics/Instrumentation, Mechatronics.

Course Objectives:

The objectives of this course are: To enable students to understand the concepts and technologies of automation used in modern manufacturing systems, including hydraulic/pneumatic circuits, PLCs, robotics integration and automated material handling.

Course Outcomes

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

CO1: Explain the basic concepts, types and levels of automation in manufacturing.

CO2: Analyze the working principles of hydraulic and pneumatic systems used in automation.

CO3: Explain the working of PLCs and their application in automation of manufacturing processes.

CO4: Describe the role of robotics and material handling systems in automated manufacturing.

CO5: Analyze flexible manufacturing systems and computer integrated manufacturing concepts.

UNIT I: INTRODUCTION TO AUTOMATION **06 Hrs.**

Definition, need and types of automation, levels of automation, automation strategies, basic elements of an automated system, advantages and limitations of automation in manufacturing.

UNIT II: HYDRAULIC AND PNEUMATIC SYSTEMS FOR AUTOMATION **08 Hrs.**

Basics of hydraulic and pneumatic systems used in automation, overview of actuators and valves, design of simple automation circuits, applications in manufacturing automation.

UNIT III: PROGRAMMABLE LOGIC CONTROLLERS **08 Hrs.**

Introduction to PLC, architecture of a PLC, basic concept of ladder logic programming, PLC input/output devices, applications of PLC in manufacturing automation.

UNIT IV: ROBOTICS AND MATERIAL HANDLING IN AUTOMATION **09 Hrs.**

Role of industrial robots in automation, overview of automated material handling systems: conveyors, AGVs and ASRS, basic concept of robotic work cell design.

UNIT V: FLEXIBLE MANUFACTURING AND COMPUTER INTEGRATED MANUFACTURING **08 Hrs.**

Flexible manufacturing systems: concept and components, computer integrated manufacturing (CIM): concept and architecture, benefits and challenges of CIM implementation.

List of Experiments:

1. Study of basic hydraulic and pneumatic automation circuits.
2. Design and simulation of a simple pneumatic automation circuit.
3. Study of PLC architecture and input/output modules.
4. Ladder logic programming for a simple automation application.

5. Interfacing sensors and actuators with a PLC.
6. Study of an automated material handling system (conveyor/AGV demonstration).
7. Study of a robotic work cell for a pick-and-place automation application.
8. Case study/visit report on a flexible manufacturing system or CIM facility.

TEXT BOOKS:

1. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 4th Edition, Pearson Education, 2015.
2. S. R. Majumdar, Pneumatic Systems: Principles and Maintenance, 2nd Edition, McGraw Hill Education, 2019.
3. W. Bolton, Programmable Logic Controllers, 6th Edition, Newnes, 2015.

REFERENCE BOOKS:

1. Frank D. Petruzella, Programmable Logic Controllers, 5th Edition, McGraw Hill Education, 2016.
2. P. Radhakrishnan, S. Subramanyan and V. Raju, CAD/CAM/CIM, 3rd Edition, New Age International, 2008.
3. Mikell P. Groover and Emory W. Zimmers, CAD/CAM: Computer-Aided Design and Manufacturing, Pearson Education, 2003.

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.

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	5 0	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**
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 SYLLABUS

Geometric Dimensioning and Tolerances

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
25ES04HT0301	Geometric Dimensioning and Tolerances	Honors	03-00-02	50	50	03

Prerequisite: Engineering Graphics, Machine Drawing.

Course Objectives:

The objectives of this course are: To enable students to understand and apply the principles of geometric dimensioning and tolerancing (GD&T) for accurate design specification, manufacturing and quality control of mechanical components.

Course Outcomes

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

CO1: Explain the fundamental concepts, symbols and rules of geometric dimensioning and tolerancing.

CO2: Apply dimensional tolerancing and fits for mechanical component design.

CO3: Apply form and orientation tolerances for geometric control of components.

CO4: Apply location and runout tolerances for geometric control of components.

CO5: Interpret and apply GD&T principles for inspection and quality control of manufactured components.

UNIT I: FUNDAMENTALS OF GD&T **06 Hrs.**

Need for GD&T, limitations of conventional dimensioning, overview of GD&T standards (ASME Y14.5), datum reference frame, feature control frame, overview of GD&T symbols.

UNIT II: DIMENSIONAL TOLERANCING AND FITS **08 Hrs.**

Types of tolerances, basic concept of tolerance stack-up analysis, limits, fits and their types, hole basis and shaft basis systems, selection of fits for engineering applications.

UNIT III: FORM AND ORIENTATION TOLERANCES **08 Hrs.**

Form tolerances: straightness, flatness, circularity and cylindricity, orientation tolerances: parallelism, perpendicularity and angularity, application of form and orientation tolerances in design.

UNIT IV: LOCATION AND RUNOUT TOLERANCES **09 Hrs.**

Location tolerances: position, concentricity and symmetry, runout tolerances: circular and total runout, basic concept of maximum material condition (MMC) and least material condition (LMC), basic concept of bonus tolerance.

UNIT V: GD&T APPLICATION IN INSPECTION AND QUALITY CONTROL **08 Hrs.**

GD&T interpretation for manufacturing drawings, inspection methods for geometric tolerances, basic concept of coordinate measuring machines (CMM), case studies of GD&T application in industry.

TEXT BOOKS:

1. Alex Krulikowski, Fundamentals of Geometric Dimensioning and Tolerancing, 3rd Edition, Cengage Learning, 2012.

2. David A. Madsen, Geometric Dimensioning and Tolerancing, 8th Edition, Goodheart-Willcox, 2016.

3. ASME Y14.5-2018, Dimensioning and Tolerancing, ASME, 2018.

REFERENCE BOOKS:

1. Georg Henzold, Geometrical Dimensioning and Tolerancing for Design, Manufacturing and Inspection, 2nd Edition, Butterworth-Heinemann, 2006.

2. Gene R. Cogorno, Geometric Dimensioning and Tolerancing for Mechanical Design, 2nd Edition, McGraw Hill Education, 2011.

3. K. Venkataraman, Design of Jigs, Fixtures and Press Tools, 1st Edition, Pearson Education, 2015.

Advanced Solid Modelling & Assembly

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
25ES04HT0401	Advanced Solid Modelling & Assembly	Honors	03-00-02	50	50	03

Prerequisite: Computer Aided Design, Geometric Dimensioning and Tolerances.

Course Objectives:

The objectives of this course are: To enable students to apply advanced solid modelling and assembly modelling techniques using CAD software for the design of complex mechanical components and assemblies.

Course Outcomes

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

CO1: Apply advanced feature-based solid modelling techniques for complex part design.

CO2: Apply surface modelling techniques for design of components with complex geometry.

CO3: Apply advanced assembly modelling techniques including mating conditions and constraints.

CO4: Analyze assembly designs for interference, tolerance stack-up and motion simulation.

CO5: Generate detailed drawings and documentation from solid models and assemblies.

UNIT I: ADVANCED SOLID MODELLING TECHNIQUES **06 Hrs.**

Review of feature-based modelling, advanced features: sweep, loft, shell and pattern, parametric and associative modelling, design intent and feature relationships.

UNIT II: SURFACE MODELLING **08 Hrs.**

Surface modelling concepts, types of surfaces: extruded, revolved, swept and lofted surfaces, surface editing and blending operations, basic concept of converting surfaces to solids.

UNIT III: ADVANCED ASSEMBLY MODELLING **08 Hrs.**

Bottom-up and top-down assembly design approaches, mating conditions and assembly constraints, sub-assemblies and assembly hierarchy, design of assemblies with standard components (fasteners, bearings).

UNIT IV: ASSEMBLY ANALYSIS **09 Hrs.**

Interference detection in assemblies, basic concept of tolerance stack-up analysis in assemblies, basic concept of motion simulation and kinematic analysis of assemblies, exploded view generation.

UNIT V: DETAILING AND DOCUMENTATION **08 Hrs.**

Generation of detailed part and assembly drawings, bill of materials (BOM) generation, drawing annotation and GD&T application in drawings, overview of CAD data management (PDM).

TEXT BOOKS:

1. Ibrahim Zeid and R. Sivasubramanian, CAD/CAM: Theory and Practice, 2nd Edition, McGraw Hill Education, 2009.
2. Sham Tickoo, SolidWorks for Engineers and Designers, CADCIM Technologies (latest edition).
3. P. N. Rao, CAD/CAM: Principles and Applications, 3rd Edition, McGraw Hill Education, 2010.

REFERENCE BOOKS:

1. Kunwoo Lee, Principles of CAD/CAM/CAE Systems, Pearson Education, 1999.
2. Chris McMahon and Jimmie Browne, CADCAM: Principles, Practice and Manufacturing Management, 2nd Edition, Pearson Education, 1998.
3. Vendor CAD software documentation (SolidWorks / CATIA / Creo Parametric user guides).

Additive Manufacturing Techniques

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
25ES04HT0501	Additive Manufacturing Techniques	Honors	04-00-02	50	50	04

Prerequisite: Manufacturing Processes, Computer Aided Design.

Course Objectives:

The objectives of this course are: To enable students to understand the principles, processes and applications of additive manufacturing technologies for rapid prototyping and production of components.

Course Outcomes

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

CO1: Explain the fundamentals, classification and applications of additive manufacturing processes.

CO2: Describe the working principles of liquid-based and solid-based additive manufacturing processes.

CO3: Describe the working principles of powder-based additive manufacturing processes.

CO4: Analyze design considerations and material selection for additive manufacturing.

CO5: Evaluate post-processing techniques and quality control aspects of additive manufacturing.

UNIT I: INTRODUCTION TO ADDITIVE MANUFACTURING **10 Hrs.**

Definition and evolution of additive manufacturing, classification of AM processes, generic AM process chain, advantages and limitations of AM, applications of AM in mechanical engineering.

UNIT II: LIQUID-BASED AND SOLID-BASED AM PROCESSES **11 Hrs.**

Stereolithography (SLA): principle and process, Fused Deposition Modeling (FDM): principle and process, overview of Digital Light Processing (DLP), applications and limitations of liquid and solid-based processes.

UNIT III: POWDER-BASED AM PROCESSES **10 Hrs.**

Selective Laser Sintering (SLS): principle and process, overview of Direct Metal Laser Sintering (DMLS) and Selective Laser Melting (SLM), basic concept of Binder Jetting, applications of powder-based AM processes.

UNIT IV: DESIGN FOR ADDITIVE MANUFACTURING **10 Hrs.**

Design for additive manufacturing (DfAM) principles, part orientation and support structure design, material selection for AM processes, basic concept of topology optimization for AM.

UNIT V: POST-PROCESSING AND QUALITY CONTROL **11 Hrs.**

Post-processing techniques: support removal, surface finishing and heat treatment, dimensional accuracy and quality control in AM, defects in AM parts and their causes, applications and case studies of AM in industry.

TEXT BOOKS:

1. Ian Gibson, David Rosen and Brent Stucker, Additive Manufacturing Technologies, 2nd Edition, Springer, 2015.

2. Amit Bandyopadhyay and Susmita Bose, Additive Manufacturing, 2nd Edition, CRC Press, 2019.

3. Chee Kai Chua and Kah Fai Leong, 3D Printing and Additive Manufacturing: Principles and Applications, 5th Edition, World Scientific, 2017.

REFERENCE BOOKS:

1. Andreas Gebhardt, Understanding Additive Manufacturing, Hanser Publications, 2011.

2. Milan Brandt (Ed.), Laser Additive Manufacturing: Materials, Design, Technologies, and Applications, Woodhead Publishing, 2016.

3. ASTM F2792, Standard Terminology for Additive Manufacturing Technologies, ASTM International.

Design for Manufacturing

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
25ES04HT0601	Design for Manufacturing	Honors	04-00-02	50	50	04

Prerequisite: Manufacturing Processes, Design of Machine Elements.

Course Objectives:

The objectives of this course are: To enable students to apply design for manufacturing and assembly (DFMA) principles to optimize product design for manufacturability, cost and quality.

Course Outcomes

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

CO1: Explain the concepts, benefits and methodology of design for manufacturing and assembly (DFMA).

CO2: Apply design for manufacturing guidelines for casting, forming and machining processes.

CO3: Apply design for manufacturing guidelines for welding and sheet metal processes.

CO4: Apply design for assembly principles to minimize assembly time and cost.

CO5: Evaluate product designs using DFMA analysis tools and techniques.

UNIT I: INTRODUCTION TO DESIGN FOR MANUFACTURING AND ASSEMBLY **10 Hrs.**

Concept and importance of DFM and DFA, product development process, general design principles for manufacturability, basic concept of cost estimation in design, overview of concurrent engineering.

UNIT II: DFM GUIDELINES FOR CASTING, FORMING AND MACHINING **11 Hrs.**

Design guidelines for casting processes, design guidelines for forging and sheet metal forming, design guidelines for machining processes, minimizing machining operations through design.

UNIT III: DFM GUIDELINES FOR WELDING AND SHEET METAL PROCESSES **10 Hrs.**

Design guidelines for welded assemblies, design guidelines for sheet metal fabrication, selection of joining processes based on design requirements, tolerancing considerations for manufacturing processes.

UNIT IV: DESIGN FOR ASSEMBLY **10 Hrs.**

Principles of design for assembly, minimizing part count, assembly sequence design, ease of assembly and handling considerations, overview of DFA analysis methods (Boothroyd-Dewhurst method).

UNIT V: DFMA TOOLS AND CASE STUDIES **11 Hrs.**

Overview of DFMA software tools, cost analysis using DFMA, case studies of product redesign using DFMA principles, applications of DFMA in the mechanical engineering industry.

TEXT BOOKS:

1. Geoffrey Boothroyd, Peter Dewhurst and Winston Knight, Product Design for Manufacture and Assembly, 3rd Edition, CRC Press, 2010.

2. James G. Bralla, Design for Manufacturability Handbook, 2nd Edition, McGraw Hill Education, 1998.

3. David M. Anderson, Design for Manufacturability: How to Use Concurrent Engineering to Rapidly Develop Low-Cost, High-Quality Products, 2nd Edition, CRC Press, 2014.

REFERENCE BOOKS:

1. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson Education, 2001.

2. Karl T. Ulrich and Steven D. Eppinger, Product Design and Development, 6th Edition, McGraw Hill Education, 2015.

3. Corrado Poli, Design for Manufacturing: A Structured Approach, Butterworth-Heinemann, 2001.

Project

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
25ES04HP0701	Project	Honors	00-08-02	50	50	04

Prerequisite: All core and honors courses of the stream (Geometric Dimensioning and Tolerances, Advanced Solid Modelling & Assembly, Additive Manufacturing Techniques, Design for Manufacturing).

Course Objectives:

The objectives of this course are: To enable students to apply the knowledge and skills acquired in the honors 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, modelling and manufacturing.

CO2: Conduct literature review and survey relevant to the identified problem.

CO3: Apply design, modelling and manufacturing 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 GD&T and advanced CAD modelling), manufacturing-based (using additive manufacturing techniques), or DFMA-based (optimizing an existing product design for manufacturability), 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 Syllabus

Basics of Mechanical Engineering

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
25ES04MT0301	Basics of Mechanical Engineering	Minor	03-00-02	50	50	03

Prerequisite: Basic Physics, Basic Mathematics (10+2 level).

Course Objectives:

The objectives of this course are: To enable students 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 **06 Hrs.**

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 **08 Hrs.**

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 **08 Hrs.**

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 **09 Hrs.**

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 **08 Hrs.**

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.

Energy System and Technologies

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
25ES04MT0401	Energy System and Technologies	Minor	03-00-02	50	50	03

Prerequisite: Basics of Mechanical Engineering, Basic Physics.

Course Objectives:

The objectives of this course are: To enable students to understand conventional and renewable energy systems and technologies for sustainable energy generation and utilization.

Course Outcomes

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

CO1: Explain the fundamentals of energy systems and the global/Indian energy scenario.

CO2: Describe the working principles of conventional power generation systems (thermal, hydro, nuclear).

CO3: Explain the principles and technologies of solar energy systems.

CO4: Explain the principles and technologies of wind, biomass and other renewable energy systems.

CO5: Evaluate energy storage, energy management and energy conservation techniques.

UNIT I: FUNDAMENTALS OF ENERGY SYSTEMS **06 Hrs.**

Forms of energy, energy conversion, classification of energy resources, global and Indian energy scenario, environmental aspects of energy utilization, basic concept of energy security.

UNIT II: CONVENTIONAL POWER GENERATION SYSTEMS **08 Hrs.**

Thermal power plant: layout and working, hydroelectric power plant: layout and working, basic concept of nuclear power plant, comparison of conventional power generation technologies.

UNIT III: SOLAR ENERGY SYSTEMS **08 Hrs.**

Basic concept of solar radiation, solar thermal systems: flat plate and concentrating collectors, solar photovoltaic systems: principle and applications, overview of solar water heating and solar drying.

UNIT IV: WIND, BIOMASS AND OTHER RENEWABLE ENERGY SYSTEMS **09 Hrs.**

Basic concept of wind energy potential and wind turbine types, overview of biomass and biogas energy systems, basics of geothermal, tidal and ocean energy, basic concept of hydrogen energy and fuel cells.

UNIT V: ENERGY STORAGE, MANAGEMENT AND CONSERVATION **08 Hrs.**

Overview of energy storage technologies, energy management principles, basic concept of energy audit, energy conservation techniques in industry and buildings, overview of government policies on energy.

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. P. K. Nag, Power Plant Engineering, 4th Edition, McGraw Hill Education, 2014.

REFERENCE BOOKS:

1. Godfrey Boyle, Renewable Energy: Power for a Sustainable Future, 3rd Edition, Oxford University Press, 2012.
2. C. S. Solanki, Renewable Energy Technologies: A Practical Guide for Beginners, 2nd Edition, PHI Learning, 2015.
3. Frank Kreith and D. Yogi Goswami (Eds.), Energy Management and Conservation Handbook, 2nd Edition, CRC Press, 2016.

Product Design & Digital Manufacturing

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
25ES04MT0501	Product Design & Digital Manufacturing	Minor	04-00-02	50	50	04

Prerequisite: Basics of Mechanical Engineering, Computer Fundamentals.

Course Objectives:

The objectives of this course are: To enable students to understand the product design process and to apply digital manufacturing technologies for the design and production of engineering products.

Course Outcomes

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

CO1: Explain the product design process and product development life cycle.

CO2: Apply computer aided design tools for product modelling.

CO3: Explain the principles of digital manufacturing and Industry 4.0 technologies.

CO4: Describe rapid prototyping and additive manufacturing techniques for product development.

CO5: Evaluate product designs for manufacturability, cost and sustainability.

UNIT I: PRODUCT DESIGN PROCESS **10 Hrs.**

Product design process: need identification, concept generation and selection, product development life cycle, basic concept of market research and product specifications, design constraints.

UNIT II: COMPUTER AIDED PRODUCT MODELLING **11 Hrs.**

Introduction to CAD software for product modelling, basic concept of 2D and 3D modelling, overview of assembly modelling, generation of product drawings and documentation.

UNIT III: DIGITAL MANUFACTURING AND INDUSTRY 4.0 **10 Hrs.**

Introduction to digital manufacturing, Industry 4.0: concept and pillars, role of IoT and cyber-physical systems in manufacturing, overview of the smart factory concept.

UNIT IV: RAPID PROTOTYPING AND ADDITIVE MANUFACTURING **10 Hrs.**

Introduction to rapid prototyping, overview of classification of additive manufacturing processes, applications of additive manufacturing in product development, basics of reverse engineering.

UNIT V: DESIGN FOR MANUFACTURABILITY AND SUSTAINABILITY **11 Hrs.**

Basic concept of design for manufacturing and assembly, cost considerations in product design, sustainable product design principles, case studies of digitally manufactured products.

TEXT BOOKS:

1. Karl T. Ulrich and Steven D. Eppinger, Product Design and Development, 6th Edition, McGraw Hill Education, 2015.

2. Ibrahim Zeid and R. Sivasubramanian, CAD/CAM: Theory and Practice, 2nd Edition, McGraw Hill Education, 2009.

3. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 4th Edition, Pearson Education, 2015.

REFERENCE BOOKS:

1. Amit Bandyopadhyay and Susmita Bose, Additive Manufacturing, 2nd Edition, CRC Press, 2019.
2. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016.
3. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson Education, 2001.

Automotive Technology

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
25ES04MT0601	Automotive Technology	Minor	04-00-02	50	50	04

Prerequisite: Basics of Mechanical Engineering, Engineering Thermodynamics.

Course Objectives:

The objectives of this course are: To enable students to understand the construction, working principles and technologies used in modern automobiles.

Course Outcomes

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

CO1: Explain the basic layout and construction of an automobile and its major systems.

CO2: Describe the working of automotive engines and their subsystems.

CO3: Explain the working of transmission and power train systems in automobiles.

CO4: Describe the working of steering, braking and suspension systems in automobiles.

CO5: Explain the fundamentals of electric and hybrid vehicle technology and vehicle emission control.

UNIT I: INTRODUCTION TO AUTOMOBILES **10 Hrs.**

Basic layout of an automobile, classification of vehicles, basic concept of chassis and body, automotive engine classification, overview of the main components of an automobile.

UNIT II: AUTOMOTIVE ENGINE SYSTEMS **11 Hrs.**

Engine components and their functions, basic concept of the fuel supply system, cooling and lubrication systems, overview of the ignition system, basic concept of engine performance parameters.

UNIT III: TRANSMISSION AND POWER TRAIN **10 Hrs.**

Clutch: types and construction, gearbox: types and working, basic concept of propeller shaft and differential, overview of automatic transmission.

UNIT IV: STEERING, BRAKING AND SUSPENSION SYSTEMS **10 Hrs.**

Steering system: types and working, braking system: types and working, suspension system: types and working, basic concept of wheels and tyres.

UNIT V: ELECTRIC/HYBRID VEHICLES AND EMISSION CONTROL **11 Hrs.**

Basics of electric and hybrid vehicle technology, overview of automotive electrical and electronics systems, basic concept of vehicle emission norms, overview of emission control technologies.

TEXT BOOKS:

1. Kirpal Singh, Automobile Engineering, Volume I & II, 13th Edition, Standard Publishers Distributors, 2011.
2. William H. Crouse and Donald L. Anglin, Automotive Mechanics, 10th Edition, McGraw Hill Education, 2007.
3. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, 3rd Edition, CRC Press, 2021.

REFERENCE BOOKS:

1. Heinz Heisler, Advanced Vehicle Technology, 2nd Edition, Butterworth-Heinemann, 2002.
2. Julian Happian-Smith, An Introduction to Modern Vehicle Design, Butterworth-Heinemann, 2001.
3. James D. Halderman, Automotive Technology: Principles, Diagnosis, and Service, 6th Edition, Pearson Education, 2018.

Project

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
25ES04MP0701	Project	Minor	00-08-02	50	50	04

Prerequisite: All core and minor courses of the stream (Basics of Mechanical Engineering, Energy System and Technologies, Product Design & Digital Manufacturing, Automotive Technology).

Course Objectives:

The objectives of this course are: To enable students to apply the knowledge and skills acquired in the minor 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, energy or automotive 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 product design and digital manufacturing tools), energy-system-based (renewable/conventional energy applications), automotive-technology-based, 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.

MDM SYLLABUS

Defense Platforms

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
25ES03TH0307	Defense Platforms	MDM	03-00-02	50	50	03

Prerequisite: Basic Mechanical/Aerospace Engineering concepts.

Course Objectives:

The objectives of this course are: To enable students to understand the classification, general configuration and technological evolution of land, air, naval and space-based defense platforms at a conceptual and historical level.

Course Outcomes

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

CO1: Explain the classification and evolution of land-based defense platforms.

CO2: Explain the classification and evolution of air-based defense platforms.

CO3: Explain the classification and evolution of naval defense platforms.

CO4: Describe the basic configuration and subsystems of modern defense platforms.

CO5: Discuss emerging trends in defense platform technology including unmanned systems.

UNIT I: INTRODUCTION TO DEFENSE PLATFORMS **06 Hrs.**

Definition and scope of defense platforms, historical evolution of military platforms, classification of platforms: land, air, naval and space-based, overview of the role of defense platforms in national security.

UNIT II: LAND-BASED DEFENSE PLATFORMS **08 Hrs.**

Overview of the classification of armored vehicles: tanks, infantry combat vehicles and armored personnel carriers, basic configuration and mobility considerations, historical overview of the evolution of land platform technology.

UNIT III: AIR-BASED DEFENSE PLATFORMS **08 Hrs.**

Overview of the classification of military aircraft: fighters, transport and reconnaissance aircraft, basic aerodynamic and propulsion considerations, historical overview of the evolution of military aviation technology.

UNIT IV: NAVAL DEFENSE PLATFORMS **09 Hrs.**

Overview of the classification of naval platforms: surface combatants, submarines and aircraft carriers, basic configuration and role of naval platforms, historical overview of the evolution of naval platform technology.

UNIT V: EMERGING PLATFORM TECHNOLOGIES **08 Hrs.**

Overview of unmanned systems: UAVs, UGVs and UUVs, basic concept of platform stealth and survivability considerations, role of automation and networking in modern defense platforms, future trends in platform technology.

TEXT BOOKS:

1. James F. Dunnigan, How to Make War: A Comprehensive Guide to Modern Warfare, 4th Edition, William Morrow, 2003.
2. David Jordan et al., Understanding Modern Warfare, 2nd Edition, Cambridge University Press, 2016.
3. Jane's Defence Yearbooks (reference series), latest edition.

REFERENCE BOOKS:

1. Ministry of Defence, Government of India, Annual Report (relevant sections), latest edition.
2. SIPRI (Stockholm International Peace Research Institute), SIPRI Yearbook: Armaments, Disarmament and International Security, latest edition.
3. Norman Friedman, Seapower as Strategy: Navies and National Interests, Naval Institute Press, 2001.

Warfare System

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
25ES03TH0407	Warfare System	MDM	03-00-02	50	50	03

Prerequisite: Defense Platforms.

Course Objectives:

The objectives of this course are: To enable students to understand the principles of modern warfare systems including command, control, communication and intelligence, network-centric warfare, electronic warfare, and cyber warfare at a conceptual level.

Course Outcomes

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

CO1: Explain the basic principles and evolution of modern warfare doctrines.

CO2: Describe command, control, communication and intelligence (C3I) systems used in warfare.

CO3: Explain the concept of network-centric warfare and information warfare.

CO4: Describe electronic warfare systems and their role in modern combat.

CO5: Discuss the role of cyber warfare and emerging technologies in modern warfare systems.

UNIT I: FUNDAMENTALS OF MODERN WARFARE **06 Hrs.**

Evolution of warfare doctrines, overview of principles of war, basic concept of conventional and unconventional warfare, levels of warfare: strategic, operational and tactical.

UNIT II: COMMAND, CONTROL, COMMUNICATION AND INTELLIGENCE (C3I) SYSTEMS **08 Hrs.**

Concept and components of C3I systems, role of communication systems in warfare, basic concept of intelligence, surveillance and reconnaissance (ISR), overview of decision-making processes in military command structures.

UNIT III: NETWORK-CENTRIC AND INFORMATION WARFARE **08 Hrs.**

Concept of network-centric warfare, basic concept and components of information warfare, role of data and connectivity in modern military operations, overview of psychological operations.

UNIT IV: ELECTRONIC WARFARE SYSTEMS **09 Hrs.**

Basic concept of electronic warfare: electronic attack, electronic protection and electronic support, basic concept of radar and communication jamming, role of electronic warfare in modern combat scenarios.

UNIT V: CYBER WARFARE AND EMERGING TECHNOLOGIES **08 Hrs.**

Basic concept of cyber warfare and its role in national security, overview of artificial intelligence applications in warfare systems, basic concept of autonomous systems in warfare, ethical and policy considerations in modern warfare technology.

TEXT BOOKS:

1. James F. Dunnigan, How to Make War: A Comprehensive Guide to Modern Warfare, 4th Edition, William Morrow, 2003.
2. David Jordan et al., Understanding Modern Warfare, 2nd Edition, Cambridge University Press, 2016.
3. Martin Libicki, Conquest in Cyberspace: National Security and Information Warfare, Cambridge University Press, 2007.

REFERENCE BOOKS:

1. Colin S. Gray, Modern Strategy, Oxford University Press, 1999.
2. P. W. Singer, Wired for War: The Robotics Revolution and Conflict in the 21st Century, Penguin Press, 2009.
3. Ministry of Defence, Government of India, Annual Report (relevant sections), latest edition.

Weapon Systems

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
25ES03TH0507	Weapon Systems	MDM	03-00-02	50	50	03

Prerequisite: Defense Platforms, Warfare System.

Course Objectives:

The objectives of this course are: To enable students to understand, at a conceptual and classification level, the general categories, historical evolution, basic physics and regulatory framework of conventional weapon systems used by modern defense forces.

Course Outcomes

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

CO1: Explain the classification of conventional weapon systems.

CO2: Describe, at a conceptual level, the general categories and historical evolution of small arms and infantry weapons.

CO3: Explain the fundamentals of ballistics and projectile motion at a basic physics level.

CO4: Describe the basic classification and general configuration of artillery and missile systems.

CO5: Discuss weapon system integration considerations, safety and international regulatory frameworks.

UNIT I: CLASSIFICATION OF WEAPON SYSTEMS **06 Hrs.**

Classification of conventional weapon systems: small arms, artillery, missiles and precision-guided munitions - overview, basic terminology used in weapon systems engineering.

UNIT II: SMALL ARMS AND INFANTRY WEAPONS - OVERVIEW **08 Hrs.**

General classification and historical evolution of small arms, overview of broad design considerations at a conceptual level, basic concept of safety features and standards in small arms.

UNIT III: FUNDAMENTALS OF BALLISTICS **08 Hrs.**

Basic concept of internal, external and terminal ballistics, projectile motion from a basic physics standpoint, conceptual overview of factors affecting range and accuracy.

UNIT IV: ARTILLERY AND MISSILE SYSTEMS - OVERVIEW **09 Hrs.**

General classification and configuration of artillery systems, general classification of missile systems: guided and unguided, conceptual overview of guidance and control in missile systems.

UNIT V: WEAPON SYSTEM INTEGRATION, SAFETY AND REGULATION **08 Hrs.**

Basic concept of weapon system integration with platforms, overview of safety and reliability considerations, international regulatory frameworks and treaties related to conventional weapons, ethical considerations in weapon system development.

TEXT BOOKS:

1. James F. Dunnigan, How to Make War: A Comprehensive Guide to Modern Warfare, 4th Edition, William Morrow, 2003.

2. Chris McNab (Ed.), The Illustrated History of Weapons, Amber Books, 2011.

3. Anthony G. Williams, Rapid Fire: The Development of Automatic Cannon, Heavy Machine Guns and Their Ammunition for Armies, Navies and Air Forces, Airlife Publishing, 2000.

REFERENCE BOOKS:

1. Ministry of Defence, Government of India, Annual Report (relevant sections), latest edition.

2. United Nations Office for Disarmament Affairs, publications on conventional arms control frameworks.

3. SIPRI (Stockholm International Peace Research Institute), SIPRI Yearbook: Armaments, Disarmament and International Security, latest edition.

Self-defense & Protection System

Course Code	Course Title	Category	L-P-S	CA	FE	Credits
25ES03TH0607	Self-defence & Protection System	MDM	03-00-02	50	50	03

Prerequisite: Nil.

Course Objectives:

The objectives of this course are: To enable students to understand personal and platform protection systems, protective equipment, camouflage principles, and emergency response and survival skills relevant to defense and civilian security applications.

Course Outcomes

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

CO1: Explain the basic principles of personal protection and situational awareness.

CO2: Describe the design categories and materials used in personal protective equipment (body armor, helmets).

CO3: Explain the basic principles of vehicle and platform armor/protection systems.

CO4: Describe camouflage, concealment and detection-avoidance principles.

CO5: Discuss emergency response, first aid and survival skills relevant to defense and security scenarios.

UNIT I: FUNDAMENTALS OF PERSONAL PROTECTION **06 Hrs.**

Concept of personal protection and situational awareness, basic principles of self-defense, basic concept of risk assessment and threat perception, role of physical fitness and training in personal protection.

UNIT II: PERSONAL PROTECTIVE EQUIPMENT **08 Hrs.**

Types and classification of body armor, overview of materials used in ballistic protection (e.g. aramid fibers, ceramic composites), basic concept of helmet design and protection levels, overview of standards and certification of protective equipment.

UNIT III: VEHICLE AND PLATFORM PROTECTION SYSTEMS **08 Hrs.**

Basic concept of vehicle armor and protection levels, overview of active and passive protection systems, basic concept of blast and mine protection, overview of materials used in platform protection.

UNIT IV: CAMOUFLAGE AND CONCEALMENT TECHNIQUES **09 Hrs.**

Principles of camouflage and concealment, types of camouflage patterns and materials, basic concept of detection-avoidance (visual, thermal and radar signature reduction), applications in defense and civilian contexts.

UNIT V: EMERGENCY RESPONSE AND SURVIVAL SKILLS **08 Hrs.**

Basic first aid and trauma care in emergency situations, basic concept of survival skills, overview of disaster and emergency response procedures, psychological resilience and stress management in high-risk scenarios.

TEXT BOOKS:

1. James F. Dunnigan, How to Make War: A Comprehensive Guide to Modern Warfare, 4th Edition, William Morrow, 2003.

2. Alexander Stilwell (Ed.), The Encyclopedia of Survival Techniques, general reference edition.

3. Indian Red Cross Society / St. John Ambulance, Standard First Aid and CPR Reference Manual, latest edition.

REFERENCE BOOKS:

1. National Disaster Management Authority, Government of India, Guidelines on Disaster Management, relevant publications.

2. Bureau of Indian Standards, relevant IS codes on personal protective equipment.

3. International Committee of the Red Cross, publications on humanitarian and protection standards.