RBU
RAMDEOBABA UNIVERSITY, NAGPUR
Formerly Shri Ramdeobaba College of Engineering & Management (RCOEM) Est. 1984
LEARN | INNOVATE | ACCOMPLISH

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 2024-25)

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.

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering
Session: 2024-25

Semester I

SN	Course Type	Course Code	Course Name	Hours/ week		Credits	Maximum Marks				ESE Duration (Hrs.)
				L	P		Cont. Evaluation		End Sem Exam	Total	
							Th	PR			
1	BSC	24HS05TH0104	Applied Physics	3	0	3	50	-	50	100	3
2	BSC	24HS05PR0104	Applied Physics Lab		2	1	0	50	-	50	-
3	BSC	24HS03TH0104	Differential Calculus and Basics of Statistics	3		3	50	-	50	100	3
4	BSC	24HS03PR0102	Computational Mathematics Lab	0	2	1	0	50	-	50	-
5	ESC	24ES03TH0101	Mechanical Marvels	1	0	1	50	-	-	50	-
6	ESC	24ES03TH0102	Engineering Mechanics	3	0	3	50	-	50	100	3
7	ESC	24ES03TH0103	Engineering Graphics	2	0	2	50	0	50	100	3
8	ESC	24ES03PR0103	Engineering Graphics Lab	0	2	1	0	50	-	50	-
9	ESC	24EE07TH0106	Basics of Electrical Engineering	2	0	2	50	0	50	100	2
10	ESC	24EE07PR0106	Basics of Electrical Engineering Lab	0	2	1	0	50	-	50	-
11	ESC	24ES03TH0104	Programming for Problem Solving	1	0	1	50	0	50	100	2
12	ESC	24ES03PR0104	Programming for Problem Solving Lab	0	2	1	0	50		50	-
13	VEC/ HSSM	24HS02TH0104	Foundational Course in Universal Human Values	1	0	1	50	-	-	50	-
			TOTAL	**16**	**10**	**21**	**400**	**240**	**300**	**950**	**16**

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering
Session: 2024-25

I - Internal Evaluation, E - External Evaluation

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	24HS02PR0102-2	Fundamentals of Indian Classical Dance: Bharatnatayam	0	2	1	24	24	50	- -
2	24HS02PR0102-3	Fundamentals of Indian Classical Dance: Kathak	0	2	1	24	24	50	- -
3	24HS02PR0102-4	Introduction to Digital Photography	0	2	1	24	24	50	- -
4	24HS02PR0102-5	Introduction to Basic Japanese Language	0	2	1	24	24	50	- -
5	24HS02PR0102-6	Art of Theatre	0	2	1	24	24	50	- -
6	24HS02PR0102-7	Introduction to French Language	0	2	1	24	24	50	- -
7	24HS02PR0102-8	Introduction to Spanish Language	0	2	1	24	24	50	- -
8	24HS02PR0102-9	Art of Painting	0	2	1	24	24	50	- -
9	24HS02PR0102- 10	Art of Drawing	0	2	1	24	24	50	- -
10	24HS02PR0102- 11	Nature Camp	0	2	1	24	24	50	- -
11	24HS02PR0102- 12	Developing Self-awareness	0	2	1	24	24	50	- -
12	24HS02PR0102- 13	Art of Poetry	0	2	1	24	24	50	- -
13	24HS02PR0102-14	Creative and Content Writing	0	2	1	24	24	50	- -
14	24HS02PR0102-15	Science of life through Bhagwad Gita	0	2	1	24	24	50	- -
15	24HS02PR0102-16	Sanskrit Sambhashan-Spoken Sanskrit	0	2	1	24	24	50	- -
16	24HS02PR0102-17	Kirtan Kala	0	2	1	24	24	50	- -
17	24HS02PR0102- 18	Introduction to German Language and Culture	0	2	1	24	24	50	- -
18	24HS02PR0202-19	Adventure Sports	0	2	1	24	24	50	- -
19	24HS02PR0202-20	Introduction to Defense Forces & Obstacle Training	0	2	1	24	24	50	- -
20	24HS02PR0202-21	First Aid & Disaster Management	0	2	1	24	24	50	- -
21	24HS02PR0202-22	Basic Nutritional Course	0	2	1	24	24	50	- -
22	24HS02PR0202-23	Stress Management Through Yoga &Meditation	0	2	1	24	24	50	- -

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering
Session: 2024-25

Semester II

SN	Course Type	Course Code	Course Name	Hours/ week		Credits	Maximum Marks				ESE Duration (Hrs.)
				L	P		Cont. Evaluation		End Sem Exam	Total	
							Th	Pr			
1	BSC	24HS03TH0214	Linear Algebra and Integral calculus	3	0	3	50	-	50	100	3
2	ESC	24ES03TH0201	Artificial Intelligence	3	0	3	50	-	50	100	3
3	ESC	24ES03TH0202	Theory of Mechanisms & Elasticity	3	0	3	50	-	50	100	3
4	ESC	24ES03TH0203	Data Structure and Algorithms	2	0	2	50	-	50	100	2
5	ESC	24ES03PR0203	Data Structure and Algorithms Lab	0	2	1	-	50	-	50	-
6	ESC	24ES03TH0204	Digital Logic Design	2	0	2	50	-	50	100	2
7	ESC	24ES03PR0204	Digital Logic Design Lab	0	2	1	-	50	-	50	-
8	AEC/ HSSM	24HS02TH0201	English for Professional Communication	2	0	2	50	-	50	100	2
9	AEC/ HSSM	24HS02PR0201	English for Professional Communication Lab	0	2	1	-	50	-	50	-
10	VSEC	24ES03TH0205	Fabrication Practices	1	0	1	50		-	50	-
11	VSEC	24ES03PR0205	Fabrication Practices Lab	0	2	1		50	-	50	-
12	CCA	24HS02PR0106-01 to 14	Liberal/Performing Arts Lab	0	2	1	-	50	-	50	-
13	CCA	24HS04PR0201	Sports-Yoga-Recreation	0	2	1	-	50		50	-
			TOTAL	**16**	**12**	**22**	**350**	**300**	**300**	**950**	**15**

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering
Session: 2024-25

Exit Option:

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

Semester III

SN	Course Type	Course Code	Course Name	Hours/Week		Credits	Maximum Marks				ESE Duration (Hrs.)
				L	P		Cont. Evaluation		End Sem Exam	Total	
							Th	Pr			
1	BSC	24HS03TH0303	Probability & Statistics	3	0	3	50	-	50	100	3
2	PCC	24ES04TH0302	Thermodynamics	3	0	3	50	-	50	100	3
3	PCC	24ES04TH0303	Manufacturing Engineering	2	0	2	50	-	50	100	2
4	PCC	24ES04PR0303	Manufacturing Engineering Lab	0	2	1	-	50	-	50	-
5	PCC	24HS01TH0302	Materials Science & Testing	2	0	2	50	-	50	100	2
6	PCC	24HS01PR0303	Materials Science & Testing Lab	0	2	1	-	50	-	50	-
7	PCC	24ES04TH0305	Introduction to Python	2	0	2	50	-	-	50	-

8	PCC	24ES04PR0305	Introduction to Python Lab	0	2	1	-	50	-	50	-
9	PCC	24ES04TH0301	Machine Drawing and CAD	1	0	1	50	-	-	50	3
10	PCC	24ES04PR0301	Machine Drawing and CAD Lab	0	2	1	-	50	-	50	-
11	OE	24ESOEC04TH0304	Open Elective-I/ MOOC	2	0	2	50	-	50	100	2
12	MDM	24ES04TH0305	MDM-I	3	0	3	50	-	50	100	3
13	AEC	24ES04TH0304	Design Thinking	0	2	1	-	50	-	50	-
			TOTAL	18	10	23	400	240	300	950	18

Semester IV

SN	Course Type	Course Code	Course Name	Hours/Week		Credits	Maximum Marks				ESE Duration (Hrs.)
				L	P		Cont. Evaluation		End Sem Exam	Total	
							Th	Pr			
1	PCC	24ES04TH0401	Mechanics of Solids	3	0	3	50	-	50	100	3
2	PCC	24ES04TH0402	Kinematics and Dynamics of Machinery	3	0	3	50	-	50	100	3
3	PCC	24ES04PR0402	Kinematics and Dynamics of Machinery Lab	0	2	1	-	50	-	50	-

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering
Session: 2024-25

4	PCC	24ES04TH0403	Fluid Mechanics and Hydraulic Machines	3	0	3	50	-	50	100	3
5	PCC	24ES04PR0403	Fluid Mechanics and Hydraulic Machines Lab	0	2	1	-	50	-	50	-
6	PCC	24ES04TH0404	Manufacturing Technology	3	0	3	50	-	50	100	3
7	PCC	24ES04PR0404	Manufacturing Technology Lab	0	2	1	-	50	-	50	-
8	CEP/FP	24ES04PR0405	Project-1 (Mini project)	0	2	1	-	50	-	50	-
9	OE	24ESOEC04TH0406	Open Elective-II/ MOOC	2	0	2	50	-	50	100	2
10	MDM	24ES04TH0405	MDM-II	3	0	3	50	-	50	100	3
11	AEC	CDPC	Basic Competitive Coding	0	2	1	-	50	-	50	-
12	VEC	24HS01TH0401	Environmental Science	1	0	1	50	-	-	50	-
13	VEC	24HS01PR0401	Environmental Science Lab	0	2	1	-	50	-	50	-
			TOTAL	18	12	24	350	300	300	950	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 Machin 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

Semester V							
Sr.	**Course**	**Course Code**	**Course Title**	**Hours/ week**	**Credits**	**Maximum marks**	**ESE Duration**

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering
Session: 2024-25

No.	Type			L	P		Continuous Evaluation		End Sem Exam	Total	(Hrs)
							Th.	Pr.			
1.	PCC	24ES04TH0501	Heat Transfer	2		2	50		50	100	3
2.	PCC	24ES04PR0501	Heat Transfer Lab		2	1		50		50	
3.	PCC	24ES04TH0502	Design of Machine Elements	2		2	50		50	100	2
4.	PCC	24ES04PR0502	Design of Machine Elements Lab		2	1		50		50	
5.	PCC	24ES04TH0503	Industrial Internet of Things (IIoT)	2		2	50		50	100	2
6.	PCC	24ES04PR0503	Industrial Internet of Things (IIoT) Lab		2	1		50		50	
7.	PSE	24ESPSE04TH0504	Program Specific Elective I	3	0	3	50		50	100	3
8.	PCC	24ES04TH0505	Instrumentation and Control	2		2	50		50	100	3
9.	PCC	24ES04PR0505	Instrumentation and Control Lab		2	1		50		50	
10.	PCC	24ES04PR0506	Comprehensive Viva	0	2	1		50		50	
11.	OE	24ESOE04TH0507	Open Elective-III/ MOOC	2	0	2	50		50	100	2
12.	MDM	24ES04THMD0503	MDM-III	3	0	3	50		50	100	3
13.	AEC/ HSSM	24HS02TH0501	Business Communication	1	2	2	50	50	-	100	
			TOTAL	**17**	**12**	**23**	**400**	**300**	**300**	**1000**	**15**

Program Specific Elective – I			
Course Code	**Course Name**	**Course Code**	**Course Name**

24ESPSE04TH0504-1	Mechanical Electrical & Plumbing	24ESPSE04TH0504-5	Data Visualization Tools
24ESPSE04TH0504-2	Automotive Powertrains	24ESPSE04TH0504-6	Digital Twins & Cyber Physical Systems
24ESPSE04TH0504-3	Advanced Materials & Composites	24ESPSE04TH0504-7	Machine Learning for Mechanical Engineering
24ESPSE04TH0504-4	Manufacturing Execution Systems	24ESPSE04TH0504-8	Ancient Indian Machines

Semester VI

Sr. No.	Course Type	Course Code	Course Title	Hours/ week		Credits	Maximum marks				ESE Duration (Hrs)
				L	P		Continuous Evaluation		End Sem Exam	Total	
							Th.	Pr.			
1.	PCC	24ES04TH0601	Mechatronics	3		3	50		50	100	3
2.	PCC	24ES04PR0601	Mechatronics Lab		2	1		50		50	-
3.	PCC	24ES04TH0602	Automation in Production	3	0	3	50	50	50	150	3
4.	PCC	24ES04TH0603	Operation Research	3	0	3	50	50	50	150	3
5.	PCC	24ES04TH0604	Automotive Technologies	3	0	3		50		50	3
6.	PSE	24ESPSE04TH0605	Program Specific Elective II	3	0	3	50		50	100	3

7.	AEC	24ES04PR0606	Product Innovation and Entrepreneurship	0	4	2		50		50	
8.	AEC	CDPC	Advanced Competitive Coding	0	2	1		50		50	
9.	Project	24ES04PR0607	Project-II	0	4	2		50		50	
10.	MDM	24ES04THMD0604	MDM-IV	3	0	3	50		50	100	3
			TOTAL	**18**	**12**	**24**	**240**	**350**	**240**	**850**	**14**

***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	
2	Prescribed Courses for B. Voc. Degree in Mechanical Engineering	Online certification Course	0	0	
3	One Month Internship at Industry/Project Work (one month)	As prescribed by Industry	0	0	

Program Specific Elective – II with Lab			
Course Code	**Course Name**	**Course Code**	**Course Name**
24ESPSE04TH0605-1	Synthesis of Mechanisms	24ESPSE04PR0605-1	Synthesis of Mechanisms lab
24ESPSE04TH0605-2	Automated System Integration	24ESPSE04PR0605-2	Automated System Integration lab
24ESPSE04TH0605-3	Industrial Internet of Things	24ESPSE04PR0605-3	Industrial Internet of Things lab
24ESPSE04TH0605-4	Hydraulics & Pneumatics	24ESPSE04PR0605-4	Hydraulics & Pneumatics lab
24ESPSE04TH0605-5	Relational DBMS	24ESPSE04PR0605-5	Relational DBMS lab

24ESPSE04TH0605-6	Automotive Mechanics	24ESPSE04PR0605-6	Automotive Mechanics lab
24ESPSE04TH0605-7	Human Factors in Engineering	24ESPSE04PR0605-7	Human Factors in Engineering lab

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

Semester VII

Sr. No.	Course Type	Course Code	Course Title	Hours/ week		Credits	Maximum marks				ESE Duration (Hrs)
				L	P		Continuous Evaluation		End Sem Exam	Total	
							Th.	Pr.			
1.	PSE	24ESPSE04TH0701	Program Specific Elective III	3	0	3	50		50	100	3
2.	PSE	24ESPSE04TH0702	Program Specific Elective IV	2	0	2	50		50	100	3
3.	PSE	24ESPSE04TH0703	Program Specific Elective V	2	0	2	50		50	100	3
4.	Project	24ES04PR0704	Major Project I	0	8	4		100		100	
5.	Audit Course	24ES04PR0705	Internship Evaluation (Min 6 weeks)			SF/ USF					
6.	EEM/ HSSM	24HS02TH0701	Engineering Economics	2	0	2	50		50	100	2
			TOTAL	**9**	**8**	**13**	**200**	**100**	**200**	**500**	**11**

Program Specific Elective – III with Lab

Course Code	Course Name	Course Code	Course Name
24ES04TH0701-1	3-D Printing & Additive Manufacturing	24ES04PR0701-1	3-D Printing & Additive Manufacturing

24ES04TH0701-2	Renewable Energy Systems	24ES04PR0701-2	Renewable Energy Systems
24ES04TH0701-3	Human Machine Interface	24ES04PR0701-3	Human Machine Interface
24ES04TH0701-4	Drone & Electric Vehicle Technology	24ES04PR0701-4	Drone & Electric Vehicle Technology

Program Specific Elective-IV			
Course Code	**Course Name**	**Course Code**	**Course Name**
24ESPSE04TH0702-1	Artificial Intelligence	24ESPSE04TH0702-7	Power Plant Engineering
24ESPSE04TH0702-2	Micro Fluidics	24ESPSE04TH0702-8	Six Sigma Management
24ESPSE04TH0702-3	Micromachining	24ESPSE04TH0702-9	Motion Control Systems
24ESPSE04TH0702-4	Wealth Creation & Management	24ESPSE04TH0702-10	Elements of Marine Engineering
24ESPSE04TH0702-5	Armament Technology in Defense	24ESPSE04TH0702-11	Space Technology
24ESPSE04TH0702-6	Introduction to Corporate Law Practice	24ESPSE04TH0702-12	Standards and Certification Processes

Semester VIII

Sr. No.	Course Type	Course Code	Course Title	Hours/ week		Credits	Maximum marks				ESE Duration (Hrs)
				L	P		Continuous Evaluation		End Sem Exam	Total	
							Th.	Pr.			
1.	PCC	24ES04TH0801	Project Management	3	0	3	50		50	100	3

2.	PCC	24ES04TH0802	Research Methodology	2	0	2	50		50	100	2
3.	IKS	24HS02TH0801	Foundational Literature of Indian Civilization	1	0	1	50	-	-	50	-
4.	Project	24ES04PR0803	Major Project II	0	12	6	-	50	50	100	
			TOTAL	**6**	**12**	**12**	150	**50**	**150**	**350**	**5**
			OR								
1.	Project	24ES04PR0804	Full Semester Industry/ Research/TBI Internship	0	24	12		150	100	240	-
			TOTAL			**12**					

Programme Specific Electives

List of Program Specific Electives for B. Tech. in Mechanical Engineering and Allied Specializations					
Semester	Mechanical and Smart Manufacturing	Mechanical and Automation Engineering	Mechanical Engineering (Design Thinking)	Mechanical Engineering (Electric Vehicle Technology)	Logistics and Supply Chain Management
Semester 5	Lean and Intelligent Manufacturing	Material handling and MES	Product Design and Development	Electric Vehicle Technology	Productivity Improvement Techniques

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering
Session: 2024-25

Semester 6	Additive Manufacturing and Reverse Engineering	Industrial Automation	Human Factors in Design	Battery Management systems	Transportation, Distribution and Warehouse Management
Semester 7	Machine Learning for Smart Manufacturing	PLC and SCADA	Design for Manufacturability	Vehicle Dynamics	Supply Chain Analytics
Semester 7	Smart Factory Design	Automation system & Control	Design Thinking for Innovation	Electric Vehicle Charging Infrastructure	Enterprise Resource Planning
Semester 7	Stress Analysis	Product lifecycle Management	System Design	Drone Technology	Multi-criteria Decision making

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	24ES03PR0709	Industry Internship Phase-I			12				350	
2	MOOC	24ES03PR0710	MOOC-I			3				175	3
3	MOOC	24ES03PR0711	MOOC-II			3				175	3
Total						**18**					**6**
One Year Internship Phase-II											
1	Internship	24ES03PR0807	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	624	224	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**	**6240**	**36**	**100**	**117**	**45**

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

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	24ESOE04TH0306	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	24ESOE04TH0406	Six Sigma Principles (13 Hour) Supply Chain Management and Analytics (34 Hour)	2	0	2	50	50	100	2
3	V	24ESOE04TH0506	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

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	24ES04HT0301	Geometric Dimensioning and Tolerances	3	0	2	3	50	50	100	3
2	IV	24ES04HT0401	Advanced Solid Modelling & Assembly	3	0	2	3	50	50	100	3
3	V	24ES04HT0501	Additive Manufacturing Techniques	4	0	2	4	50	50	100	3
4	VI	24ES04HT0601	Design for Manufacturing	4	0	2	4	50	50	100	3
5	VII	24ES04HP0701	Project	0	8	2	4	50	50	100	3
			TOTAL	**14**	**8**	**10**	**18**	**240**	**240**	**500**	**15**

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

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering
Session: 2024-25

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	24ES04MT0301	Basics of Mechanical Engineering	3	0	2	3	50	50	100	3
2	IV	24ES04MT0401	Energy system and technologies	3	0	2	3	50	50	100	3
3	V	24ES04MT0501	Product Design & Digital Manufacturing	4	0	2	4	50	50	100	3
4	VI	24ES04MT0601	Automotive Technology	4	0	2	4	50	50	100	3
5	VII	24ES04MP0701	Project	0	8	2	4	50	50	100	3
			TOTAL	**14**	**8**	**10**	**18**	**240**	**240**	500	15

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	24ES03TH0307	Défense Platforms	3	0	2	3	50	50	100	3
2	IV	24ES03TH0407	Warfare system	3	0	2	3	50	50	100	3
3	V	24ES03TH0507	Weapon Systems	3	0	2	3	50	50	100	3
4	VI	24ES03TH0607	Self-defence & Protection system	3	0	2	3	50	50	100	3
			TOTAL	**12**	**0**	**8**	**12**				

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering
Session: 2024-25

Programme Syllabus Semester-I

Course Code	Course Title				Category
24HS05TH0104	**Applied Physics**				BSC
Contact Hours per Week			**CA**	**FE**	**Total**	**Credits**
L	**P**	**S**				
3	2	2	50	50	100	3

Prerequisite: NA

Course Objectives (COs):

1. To impart fundamental knowledge of oscillations, waves, optics, semiconductors, quantum mechanics, and materials that form the basis of engineering applications.
2. To enable students to apply the concepts of physics in analyzing and solving engineering problems.
3. To develop the ability to integrate physical principles with technological advancements in electronics, materials, and nanotechnology.
4. To foster problem-solving skills through experiments, analytical methods, and applications of physical laws.
5. To prepare students for higher studies and interdisciplinary research by strengthening their understanding of applied physics concepts.

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

- Apply the principles of oscillations, waves, and acoustics in engineering applications.
- Explain and analyze the concepts of optics, interference, diffraction, and polarization.
- Understand semiconductor physics and apply it to electronic devices.
- Illustrate the fundamentals of quantum mechanics and its applications.
- Apply knowledge of material science and superconductivity in engineering contexts.

UNIT I: Oscillations, Waves, and Acoustics	**7 Hrs.**

- Simple harmonic motion, damped and forced oscillations, resonance.
- Waves: Types of waves, wave equation, velocity of waves in different media.
- Acoustics of buildings: Reverberation, absorption coefficient, Sabine's formula, sound insulation, sound absorption materials.

UNIT II: Optics	**8 Hrs.**

- Interference of light: Newton's rings, thin films.
- Diffraction: Single slit and diffraction grating, resolving power of grating.
- Polarization: Methods of polarization, Malus law, double refraction, Nicol's prism, half and quarter wave plates, engineering applications.

UNIT III: Semiconductor Physics	**7 Hrs.**

- Intrinsic and extrinsic semiconductors, Fermi level, carrier concentration.
- Hall effect and applications.
- pn-junction diode, Zener diode, LED, photodiode, solar cell.
- Applications of semiconductors in engineering devices.

UNIT IV: Quantum Mechanics	**10 Hrs.**

- Dual nature of matter and radiation, de-Broglie hypothesis.
- Heisenberg's uncertainty principle.
- Schrödinger's wave equation and its applications: particle in a box.
- Quantum tunneling, quantum wells, wires, and dots.

- Applications in nanotechnology.

UNIT V: Material Science and Superconductivity	**8 Hrs.**

- Crystal structure: Types of lattices, Miller indices.
- X-ray diffraction – Bragg's law.
- Magnetic materials: Dia, para, ferro, antiferro and ferri-magnetism.
- Superconductivity: Properties, Meissner effect, types of superconductors, applications in engineering (SQUID, maglev trains, MRI).

TEXT BOOKS/ REFERENCE BOOKS:

1. Ajoy Ghatak, Optics, Tata McGraw Hill Education, 5th Edition, 2012.
2. M.N. Avadhanulu and P.G. Kshirsagar, A Textbook of Engineering Physics, S. Chand Publications, 2010.
3. H.K. Malik and A.K. Singh, Engineering Physics, Tata McGraw Hill, 2017.
4. S. O. Pillai, Solid State Physics, New Age International, 2007.
5. Arthur Beiser, Concepts of Modern Physics, Tata McGraw Hill, 6th Edition, 2009.
6. P. K. Palanisamy, Engineering Physics, Scitech Publications, 2009.
7. Rajendran V. and Marikani, Applied Physics for Engineers, Tata McGraw Hill, 2011.
8. S. O. Kasap, Principles of Electronic Materials and Devices, McGraw Hill, 2007.
9. Charles Kittel, Introduction to Solid State Physics, 8th Edition, Wiley India, 2005.

Course Code	**Course Title**				**Category**
24HS05PR0104	**Applied Physics Lab**				BSC
Contact Hours per Week			**CA**	**FE**	**Total**	**Credits**
L	**P**	**S**				
3	2	2	50	50	100	3

Prerequisite: NA

Course Objectives (COs):

1. To provide hands-on experience in verifying fundamental principles of physics studied in theory.
2. To develop skills in measurement techniques and error analysis.
3. To train students in handling basic scientific instruments relevant to optics, electricity, and materials.
4. To enhance analytical and experimental problem-solving abilities through laboratory practice.
5. To cultivate a scientific approach and experimental verification mindset for engineering applications.

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

1. Perform experiments on optics, semiconductors, and material properties using standard laboratory instruments.
2. Analyze experimental data, calculate errors, and interpret results.
3. Demonstrate the working principle of devices like lasers, LEDs, and diodes through experiments.
4. Apply theoretical physics knowledge to real-world engineering applications.
5. Work effectively in teams, follow lab protocols, and prepare technical reports.

List of Suggested Experiments (Any 8–10 to be performed):

1. Determination of wavelength of sodium light using Newton's rings.
2. Determination of wavelength of laser light using diffraction grating.
3. Determination of radius of curvature of a plano-convex lens using Newton's rings method.
4. Determination of refractive index of a prism using spectrometer.
5. Determination of acceptance angle and numerical aperture of an optical fiber.
6. Verification of Malus law using polarizer and analyzer.
7. Study of Hall effect and determination of Hall coefficient.
8. Determination of band gap of a semiconductor using PN junction diode.
9. Determination of energy gap of semiconductor by four-probe method.
10. Verification of Stefan's law of radiation.
11. Determination of thermal conductivity of a bad conductor.
12. Study of magnetic hysteresis loop and calculation of retentivity and coercivity.
13. Determination of Planck's constant using LED.

TEXT BOOKS/ REFERENCE BOOKS:

10. Ajoy Ghatak, Optics, Tata McGraw Hill Education, 5th Edition, 2012.
11. M.N. Avadhanulu and P.G. Kshirsagar, A Textbook of Engineering Physics, S. Chand Publications, 2010.
12. H.K. Malik and A.K. Singh, Engineering Physics, Tata McGraw Hill, 2017.
13. S. O. Pillai, Solid State Physics, New Age International, 2007.
14. Arthur Beiser, Concepts of Modern Physics, Tata McGraw Hill, 6th Edition, 2009.
15. P. K. Palanisamy, Engineering Physics, Scitech Publications, 2009.
16. Rajendran V. and Marikani, Applied Physics for Engineers, Tata McGraw Hill, 2011.
17. S. O. Kasap, Principles of Electronic Materials and Devices, McGraw Hill, 2007.
18. Charles Kittel, Introduction to Solid State Physics, 8th Edition, Wiley India, 2005.

Course Code			Course Title			Category
24HS03TH0104			**Differential Calculus and Basics of Statistics**			BSC
Contact Hours per Week			**CA**	**FE**	**Total**	**Credits**
L	**P**	**S**				
3	2	2	50+50	50	150	4

Prerequisite: NA

Course Objectives:

The objective of this course is to familiarize the prospective engineers with techniques in Ordinary differential equation, statistics, probability and differential calculus.

It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.

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

- Recognize first order ordinary differential equations that can be solved by each of the four methods – Linear DE, exact DE, reducible to linear DE and reducible to exact differential equations and use the appropriate method to solve them.
- Solve higher order ordinary differential equations with constant and variable coefficients.
- Find best fit curve by method of least square method and calculate correlation, regressions.
- Internalize multivariable calculus and apply it find Jacobean, maxima and minima of function.
- Solve partial differential equation by using Variable separable method

UNIT I: First order ordinary differential equations	**7 Hrs.**
Exact, linear and Bernoulli's equations, Euler's equations, Equations not 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	**8 Hrs.**
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	**7 Hrs.**
Curve fitting by the method of least squares- fitting of straight lines, second degree parabolasand more general curves, correlation and regression – Rank correlation, Multiple regression and correlation and its application in Engineering.	
UNIT IV: Differential Calculus	**10 Hrs.**
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 Hrs.**
Partial differential equations with separation of variables, boundary value problems: vibrations of a string, heat equation, potential equation, vibrations of circular membranes.	

TEXT BOOKS/ REFERENCE BOOKS:

19. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
20. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley India, 2009.
21. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.
22. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
23. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.
24. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
25. Theory and Problems of probability and statistics : 2nded :*J. R. Spiegal ,Schaum series*
26. A text book of Applied Mathematics Volume I & II, by P. N. Wartikar and J. N. Wartikar, Pune VidhyarthiGrihaPrakashan, Pune-411030 (India).
27. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.

Course Code	**Course Title**			**Category**
24EE07TH0106	**Basics of Electrical Engineering**			ESC
Contact Hours per Week	**CA**	**FE**	**Total**	**Credits**

L	P	S			
2	2	2	50+50	50 150	3

Prerequisite: NA

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:
CO1. Explain the basics of Electrical systems and various components.
CO2. Identify the various components in Electro-mechanical systems.
CO3. Classify the types of power converters as per the applications.
CO4. Select the battery for specific application.

UNIT I: Introduction to Electrical System:	**7 Hrs**

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:	**8 Hrs**

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

UNIT III: Electrical Machines:	**7 Hrs**

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 Hrs**

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:

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

Course Code	Course Title				Category
24ES03TH0102	**Engineering Mechanics**				ESC
Contact Hours per Week			**CA**	**FE**	**Total**	**Credits**
L	**P**	**S**				
3	0	1	50+50	50	150	03

Prerequisite: NA

Course Objectives:
The primary objective of the study of engineering mechanics is to develop the capacity to predict the effects of force and motion while carrying out the creative design functions of engineering.

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

1. Understand and apply the basic principles of mechanics, including Newton's laws of motion, to analyze the behavior of physical systems.
2. Understand the physical significance of Center of Gravity, Centroid and Moments of Inertia
3. Analyze the kinematics of rigid bodies for rotation about a fixed axis, general planar motion. Apply equation of motion to solve problems involving the kinetics of rigid bodies, including the computation of forces and torques resulting from linear and angular motions.
4. Evaluate the system by Work and Energy principle as well as Impulse and Momentum principle
5. Understand and analyze the dynamics of rigid bodies in terms of translation, rotation, and general plane motion.

UNIT I: Properties of surfaces & solids	**7 Hrs**

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: Introduction to power converters	**8 Hrs**

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.

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

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

Kinematics of a Particle: Rectilinear Kinematics, General Curvilinear Motion, Projectile motion.
Kinetics of a Particle: Newton's Second Law of Motion, Equation of Motion for a System of Particles

UNIT IV: Work and Energy principle:	**8 Hrs**

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 and Momentum: 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 o f Particles

Unit V: Dynamics of Rigid Body	**7 Hrs**

Kinematics of a Rigid Body: Introduction, Types of rigid body motion, Fixed-axis rotation, Plane Motion.

Kinetics of rigid body: Equation of plane 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
24ES03TH0103	**Engineering Graphics**					ESC
Contact Hours per Week			**CA**	**FE**	**Total**	**Credits**
L	**P**	**S**				
2	2	2	50+50	50	150	3

Prerequisite: NA

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

- Draw and interpret technical drawings
- Convert 2-D to 3-D drawing and vice versa.
- Represent the various positions of planes and solids in different orientations.
- Develop the solid surface for sheet metal working

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: **5 Hrs**

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: **5 Hrs**

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: **6 Hrs**

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: **5 Hrs**

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.

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

- Draw and interpret technical drawings.
- Convert 2-D to 3-D drawing and vice versa
- Represent the various positions of planes and solids in different orientations.
- Develop the solid surface for sheet metal working
- Use & demonstrate drafting package.

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

SN	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
24ES03TH0104	**Programming for Problem Solving**				ESC
Contact Hours per Week			**CA**	**FE**	**Total**	**Credits**
L	**P**	**S**				
2	2	2	50+50	-	100	3

Prerequisite:

Course Objectives:

The objective of this course is to develop foundational programming skills to design, implement, and analyse simple algorithms and data structures, using the C programming language, with a focus on solving real-world problems

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

- Understand the components of a computer system and develop algorithms using flowcharts and pseudo-code.
- Demonstrate proficiency in C programming, including the use of data types, operators, control statements, loops, and functions.
- Utilize arrays, implement basic sorting algorithms, and understand the concept of algorithm complexity through example programs.
- Apply pointers and structures in programming, and perform file handling operations including file input/output in C.

UNIT I: Introduction to Programming:	**5 Hrs**
Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.)Idea of Algorithm: Steps to solve logical and numerical problems. Representation of Algorithm: Flowchart /Pseudo code with examples. Arithmetic expressions and precedence	
UNIT II: C Programming Language:	**5 Hrs**
Introduction to C language: Keywords, Constant, Variable, Data types, Operators, Types of Statements, Pre-processor Directives, Decision Control Statement-if, if-else, nested if-else statement, switch case, Loops and Writing and evaluation of conditionals and consequent branching.	
UNIT III: Arrays and Basic Algorithms:	**5 Hrs**
Arrays: 1-D, 2-D, Character arrays and Strings. Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)	
UNIT IV: Functions and Recursion:	**5 Hrs**
User defined and Library Functions, Parameter passing in functions, call by value, passing arrays to functions: idea of call by reference. Recursion: As a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.	
UNIT V: Pointers and Structures:	**5 Hrs**
Structures, Defining structures, Array of Structures, Introduction to pointers, Defining pointers, Pointer arithmetic, pointer operators, Use of Pointers in self-referential structures, notion of linked list (no implementation)	
UNIT VI: File handling:	**5 Hrs**
Streams in C, Types of Files, File Input/ Output Operations: Modes of file opening, Reading and writing the file, closing the files etc.	

TEXT BOOKS:

1. Programming in ANSI C: E. Balguruswami McGraw Hill
2. Mastering C: K. R. Venugopal and S. R. Prasad, Tata McGraw Hill

REFERENCE BOOKS:

1. Programming with C: Byron Gottfried, Schaums Outline Series.
2. Let Us C: Yashwant Kanetkar, BPB Publication

Course Code	Course Title	Category

24HS02TH0104		**Foundational Course in Universal Human Values**				VEC/ HSSM
Contact Hours per Week			**CA**	**FE**	**Total**	**Credits**
L	**P**	**S**				
1	0	1	50+50	-	100	1

Prerequisite:

Course Objectives:

- To help the student see the need for developing a holistic perspective of life
- To sensitize the student about the scope of life – individual, family (inter-personal relationship), society and nature/existence.
- To strengthen self-reflection.
- To develop more confidence and commitment to understand, learn and act accordingly.

Course outcome:

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

CO1. Develop a holistic perspective of life
CO2. Better understanding of inter-personal relationships and relationship with society and nature.
CO3. An ability to strengthen self-reflection

UNIT I: Aspirations and concerns	**4 Hrs**

Need for Value Education: Guidelines and content of value education. Exploring our aspirations and concerns: Knowing yourself, Basic human aspirations Need for a holistic perspective, Role of UHV; Self-Management: harmony in human being

UNIT II: Health	**4 Hrs**

Harmony of the self and Body, Mental and physical health; Health for family, friends and society.

UNIT III: Relationships and Society	**5 Hrs**

Harmony in relationships, Foundational values: Trust, Respect, Reverence for excellence, Gratitude and love; harmony in society; harmony with nature.

TEXT BOOK:

R.R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and professional Ethics, Excel books, New Delhi, 10030, ISBN 978-8-174- 46781-2

REFERENCE BOOKS:

1. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
2. PL Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Purblishers.
3. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
4. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and HarperCollins, USA
5. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, limits to Growth, Club of Rome's Report, and Universe Books.
6. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) Krishi Tantra Shodh, Amravati.
7. A Nagraj, 1998, Jeevan VidyaekParichay, Divya Path Sansthan, Amarkantak.
8. E.F. Schumacher, 1973, small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
9. A.N. Tripathy, 2003, Human Values, New Age International Publishers.

SEMESTER - II

Course Code	Course Title				Category
24HS03TH0214	**Linear Algebra and Integral Calculus**				BCC
Contact Hours per Week			**CA**	**FE**	**Total**	**Credits**
L	**P**	**S**				
3	0	1	50	50	100	3

Prerequisite: None.

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 module students will be able to:

CO1. Interpret the solutions of system of linear equations and use the concepts of Eigen values, Eigen vectors to find diagonalization of matrices, reduction of quadratic form to canonical form.
CO2. Evaluate definite and improper integrals using Beta, Gamma functions. Also trace Cartesian curves.
CO3. Solve multiple integration by change of order, change of variable methods and apply it to findarea, volume, mass and centerof gravity.
CO4. Understand geometric meaning of gradient, curl, divergence
CO5. Perform line, surface and volume integrals of vector-valued functions

UNIT I: Linear Algebra	**09 Hrs.**

Rank-nullity theorem; System of linearequations; Symmetric, skew-symmetric and orthogonal matrices; Eigenvaluesand eigenvectors; Diagonalization of matrices; Orthogonaltransformation and quadratic to canonical forms, Introduction to n-dimensional space, Sinular value decomposition and its application in reducing the dimensionality of images and data .

UNIT II: Integral Calculus	**09 Hrs.**

Evaluation of definite and improper integrals; Beta and Gammafunctions and their properties; Tracing of curves (Cartesian form)65

UNIT III: Multiple Integrals	**9 Hrs.**

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

UNIT IV: Vector Calculus (Differentiation)	**9 Hrs.**
Scalar point function, Vector point function, vector differentiation, gradient, divergence and curl, directional derivatives with their physical interpretations, solenoidal and irrotational motions, Scalar potential function.	
UNIT V: Vector Calculus (Integration)	**9 Hrs.**
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. Rolle's theorem, Mean value theorems, Indeterminate forms, Applications of definite integrals to evaluate perimeter, area, surface areas and volumes of revolutions.	

TEXT BOOKS:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.

REFERENCE BOOKS:

1. P. N. Wartikar and J. N. Wartikar, A text book of Applied Mathematics Volume I & II, Pune Vidhyarthi Griha Prakashan, Pune-411030 (India).
   Biomedical Statistics –ShantikumarYadav , Sompal Singh, Ruchika Gupta
2. Theory and Problems of Probability and Statistics - M.R. Spiegal (McGraw Hill) Schaum Series.

Course Code	**Course Title**				**Category**
24ES03TH0201	**Introduction to Artificial Intelligence**				ESC
Contact Hours per Week		**CA**	**FE**	**Total**	**Credits**
L	**P** / **S**				
3	0 / 1	50	50	100	3

Prerequisite: None.

Course Objectives:

1. To introduce classical AI and rational intelligent agents.
2. To introduce techniques for problem solving by search and adversarial games.
3. To introduce constraints, logic, and inference techniques
4. To introduce planning, acting, and multi-agent systems.
5. To introduce knowledge-representation and reasoning.

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

CO1. Analyse different elements of an AI system.
CO2. Apply elementary principles of AI for problem solving and search
CO3. Apply constraints and logic for intelligent systems
CO4. Apply knowledge representation and reasoning for defining intelligent systems

UNIT I: Introduction to Artificial Intelligence	**9 Hrs.**

History and Foundations of AI, Rational Intelligent Agents, Agents and Environments, Nature of Environments, Structure of Agents.	
UNIT II: Constraint Artificial Intelligence	**9 Hrs.**
Constraint Satisfaction Problems, Inference in CSPs, Backtracking Search; Knowledge-Based Agents, Propositional and First-Order Logic, Resolution Theorem Proving, Unification Forward and Backward Chaining	
UNIT III: Multiple Integrals	**9 Hrs.**
Constraint Satisfaction Problems, Inference in CSPs, Backtracking Search; Knowledge-Based Agents, Propositional and First-Order Logic, Resolution Theorem Proving, Unification Forward and Backward Chaining	
UNIT IV: Vector Calculus (Differentiation)	**9 Hrs.**
Classical Planning: Algorithms for Planning, Planning Graphs, Hierarchical Planning, Planning and Acting in Nondeterministic Domain, Multi-Agent Planning; Knowledge Representation: Ontological Engineering, Categories and Objects, Events, Reasoning with Default Information.	
UNIT V: Vector Calculus (Integration)	**9 Hrs.**
Classical Planning: Algorithms for Planning, Planning Graphs, Hierarchical Planning, Planning and Acting in Nondeterministic Domain, Multi-Agent Planning; Knowledge Representation: Ontological Engineering, Categories and Objects, Events, Reasoning with Default Information.	
TEXT BOOKS: Russell, Stuart Jonathan, Norvig, Peter, Davis, Ernest. Artificial Intelligence: A Modern Approach. United Kingdom: Pearson, 2010.	
REFERENCE BOOKS: 1 Deepak Khemani. A First Course in Artificial Intelligence. McGraw Hill Education (India), 2013. Denis Rothman. Artificial Intelligence by Example, Packt, 2018. .	

Course Code	**Course Title**				**Category**
24ES03TH0202	**Theory of Mechanisms & Elasticity**				ESC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	0	1	50	50	3
Prerequisite: None.					
Course Objectives: ● To impart the basic knowledge the machines and mechanisms as well as mechanics of material.					

Course Outcomes: On successful completion of the module students will be able to:
After completing this course, students will be able to

CO1. Describe the functioning of a machine, the relationship between the number of links and joints and to determine its mobility.
CO2. Explain the inversions of mechanism and their applications.
CO3. Classify and synthesize the cams for different follower motions.
CO4. Understand basic concept of stress, strain and their relations based on linear elasticity, material behaviour due to different types of loading.
CO5. Learnanalyticalandgraphicalanalysisofcompoundstressesandanalysisofstrainenergy.
CO6. Develop shear force – bending moment diagram of beams under different loading conditions & support conditions and analyse bending & shear stresses in beams.

UNIT I: Basics of Mechanisms and Machines	**9 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	**9Hrs.**

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	**9 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	**9 Hrs.**

Concept of Elasticity, types of stresses, Hooke's law, stress and strain diagram; statically indeterminate systems, elastic constants and their relations; Factor of safety Thermal stresses and strain.

UNIT V: Compound stresses and strain	**9 Hrs.**

Normal and shear stress on inclined plane, principal stresses and principal planes, maximum shear stresses, Mohr's circle Strain energy: Strain energy stored in a body subjected to axial loading, & impact loading.

Unit–VI: Shear force and bending moment **9Hrs.**

Relation between load, shear force and bending moment, Shear force and bending moment diagrams for different types of beams subjected to different types of 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
24ES03TH0204	**Digital Logic Design**				ESC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
2	2	1	50	50	3

Prerequisite: None.

Course Objectives:
CO 1. Apply various optimization techniques to minimize digital circuits.
CO 2. Design combinational logic circuits.
CO 3. Analyze and design asynchronous and synchronous sequential circuits.
CO 4. Discuss x 86 architecture

Course Outcomes:
After completing this course, students will be able to
1. Apply various optimization techniques to minimize digital circuits.
2. Design combinational logic circuits.
3. Analyze and design asynchronous and synchronous sequential circuits.
4. Discuss x 86 architecture

UNIT I: Basics of Digital Electronics:	**09 Hrs.**
Basics of Digital Electronics: Motivation for digital systems: Number Systems and arithmetic's, Logic and Boolean algebra, logic gates & truth tables, SOP, POS, Minimization of combinational circuits using Karnaugh- maps.	
UNIT II: Combinational Circuit Design:	**09 Hrs.**
Combinational Circuit Design: Multiplexers, De-multiplexers, Encoders, Decoders, Code Converters, Adders, Subtractor (Half, Full), BCD Adder/ Subtractor, ripple and carry look-ahead addition, Unsigned Multiplier.	
UNIT III: Sequential circuit Design-I:	**9 Hrs.**
Sequential circuit Design-I: Storage elements, Flip-flops and latches: D, T, J/K, S/R flip-flops: level triggered, edge triggered, Master Slave flip-flop, flip flop conversion, timing analysis.	
UNIT IV:	**9 Hrs.**
Sequential circuit Design-II: Design of asynchronous and synchronous counters, Registers & Shift registers, Application of shift register: ring counter, Johnson counter, sequence generator and detector, serial adder; Linear feedback shift register (LFSR)	
UNIT V: Trees and Graphs	**9 Hrs.**

Design of synchronous sequential circuit using Mealy model and Moore model: state transition diagram, algorithm state machine (ASM) chart
TEXT BOOKS: 1. Donald P. Leach, Albert P. Malvino and GoutamSaha, “Digital Principles & Applications 8e”, McGraw Hill 2. Douglas V. Hall “Microprocessors and Interfacing” Tata McGraw Hill Education Private Limited, 2005
REFERENCE BOOKS: 1. Thomas L Floyd, “Digital Fundamentals 9e”, Pearson 2. M. Morris Mano and Michael D. Ciletti, “Digital Design 5e”, Pearson 3. Taub and Shilling, “Digital Integrated Electronics”, McGraw Hill 4. A. Anand Kumar, “Fundamentals of Digital Circuits” Fourth Edition, PHI 5. Kip R. Irvine, “Assembly Language for x86 Processors” Seventh Edition, Pearson Education

Course Code	**Course Title**				**Category**
24ES03TH0203	**Data Structure and Data Structure and Algo**				ESC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
2	2	2	50	50	3

Prerequisite: None.

Course Objectives:
Equip students with the knowledge and skills to design, implement, and analyse fundamental data structures and algorithms, enabling them to efficiently solve complex problems and optimize performance in computational applications.

Course Outcomes: On successful completion of the module students will be able to:
After completing this course, students will be able to

CO1. Identify different ADTs, their operations and specify their complexities.
CO2. Apply linear data structures to address practical challenges and analyse their complexity.
CO3. Implement different sorting, searching, and hashing methods and analyse their time and space requirements. Analyse non-linear data structures to develop solutions for real-world applications

UNIT I: Data Structures and Algorithms Basics	**09 Hrs.**

Introduction: Basic terminologies, elementary data organizations, data structure operations; abstract data types (ADT) and their characteristics. Algorithms: Definition, characteristics, analysis of an algorithm, asymptotic notations, and time and space trade-offs. Array ADT: Definition, operations and representations – row-major and column- major.

UNIT II: Sorting, Searching and Hashing	**09 Hrs.**

Sorting: Different approaches to sorting, properties of different sorting algorithms (insertion, Shell, quick, merge, heap, counting), performance analysis and comparison. Searching: Necessity of a robust search mechanism, searching linear lists (linear search, binary search) and complexity analysis of search methods. Hashing: Hash functions and hash tables, closed and open hashing, randomization methods (division method, mid-square method, folding), collision resolution techniques.

UNIT III: Stacks and Queues	**9 Hrs.**

Stack ADT: Allowable operations, algorithms and their complexity analysis, applications of stacks–expression conversion and evaluation (algorithmic analysis), multiple stacks.Queue ADT: Allowable operations, algorithms and their complexity analysis for simple queue and circular queue, introduction to double-ended queues and priority queues.

UNIT IV: Linked Lists	**9 Hrs.**

Singly Linked Lists: Representation in memory, algorithms of several operations: traversing, searching, insertion, deletion, reversal, ordering, etc. Doubly and Circular Linked Lists: Operations and algorithmic analysis. Linked representation of stacks and queues.

UNIT V: Trees and Graphs	**9 Hrs.**

Trees: Basic tree terminologies, binary tree and operations, binary search tree (BST) and operations with time analysis of algorithms, threaded binary trees. Self-balancing Search Trees: Tree rotations, AVL tree and operations, Graphs: Basic terminologies, representation of graphs, traversals (DFS, BFS) with complexity analysis, path finding (Dijkstra's SSSP, Floyd's APSP), and spanning tree (Prim's and Kruskal's algorithms).

TEXT BOOKS:

1. G.A.V. Pai, Data Structures and Algorithms: Concepts, Techniques and Application, First Edition, McGraw Hill, 2017.
2. Ellis Horowitz, SartajSahni and Susan Anderson-Freed, Fundamentals of Data Structures in C, Second Edition, Universities Press, 2008.
3. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, Third Edition, Pearson Education, 2007.
4. Thomas H Cormen, Algorithms Unlocked, MIT Press, 2013

REFERENCE BOOKS:

1. ReemaThareja, Data Structures using C, Third Edition, Oxford University Press, 2023
2. NarasimhaKarumanchi, Data Structures and Algorithms Made Easy: Data Structures and Algorithmic Puzzles Fifth Edition, Career Monk Publications, 2016.
3. Aditya Bhargava, Grokking Algorithms: An Illustrated Guide for Programmers and Other Curious People, First Edition, Manning Publications, 2016.
4. K. R. Venugopal and Sudeep R. Prasad, Mastering C, Second Edition, McGraw Hill,2015.
5. A. K. Sharma, Data Structures using C, Second Edition, Pearson Education, 2013.

Course Code: 24ES04TP0203			**Course: Data Structure and Algo Lab**
L:0	**P:2**	**S:0**	**Total Credits: 1**

List of Experiments

1. To verify truth table of different logic gates.
2. Design basic logic gates using universal gate and verify its truth table.
3. To verify following Boolean expressions using gates and Multisim software.

a) A+AB+AB
b) AB(C+AC)
4. To implement the following arithmetic circuits using (a) logic gates IC's and (b) using Multisim software.
a) Full adder
b) Half subtractor
5. Implement the function F = Σm (1,3,5,7,8,9,11,13,15) using 16:1 and 8:1 multiplexer.
6. Verify the truth table of SR, JK, JKMS, T and D flip flop.
7. To study the following functions of Shift register using IC 7495
a) SIPO
b) PIPO
c) PISO
d) SISO
8. Design and verify 2-bit synchronous down counter using S-R flip-flop.
9. Design and verify the functionality of a sequence detector to detect the sequence 1101 using Melay and Moore model and use J-K flop-flop to implement the design.

Course Code			**Course Title**			**Category**
24HS02TH0201			**English for Professional Communication**			AEC/ HSSM
Contact Hours per Week			**CA**	**FE**	**Total**	**Credits**
L	**P**	**S**				
2	2	1	50 +24	50 +24	150	3

Prerequisite:

Course Objectives:
The main objective of this course is to enhance the employability skills of students as well as prepare them for effective work place communication.

CO1. Demonstrate effective use of word power in written as well as oral communication.
CO2. Understand the techniques of listening and apply the techniques of reading comprehension used in professional communication.
CO3. Apply the principles of functional grammar in everyday as well as professional communication.
CO4. Effectively implement the comprehensive principles of written communication by applying various writing styles.
CO5. Create precise and accurate written communication products.

UNIT I: Vocabulary Building — **5 Hrs**

1. Importance of using appropriate vocabulary.
2. Techniques of vocabulary development.
3. Commonly used power verbs, power adjectives and power adverbs.
4. Synonyms, antonyms, phrases & idioms, one-word substitutions and standard abbreviations.

UNIT II: Listening and Reading Comprehension	**5 Hrs**
1. Listening Comprehension: active listening, reasons for poor listening, traits of a good listener, and barriers to effective listening. 2. Reading Comprehension: types and strategies.	
UNIT III: Functional Grammar and Usage	**6 Hrs**
1. Identifying Common Errors in use of: articles, prepositions, modifiers, modal auxiliaries, redundancies, and clichés. 2. Tenses 3. Subject-verb agreement, noun-pronoun agreement 4. Voice	
UNIT IV: Writing Skills	**5 Hrs**
1. Sentence Structures 2. Sentence Types 3. Paragraph Writing: Principles, Techniques, and Styles	
UNIT V: Unit-5: Writing Practices	**5 Hrs**
1. Art of Condensation: Précis, Summary, and Note Making 2. Correspondence writing techniques and etiquettes – academic writing 3. Essay Writing	

TEXT BOOKS:

1. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 10031.
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. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press.

Course Objective

To enhance competency of communication in English among learners

Course Outcomes

On completion of English Lab course, students will be able to achieve the following:

- Apply effective listening and speaking skills in professional and everyday conversations.
- Demonstrate the techniques of effective Presentation Skills
- Evaluate and apply the effective strategies for Group Discussions
- Analyze and apply the effective strategies for Personal Interviews
- Implement essential language skills- listening, speaking, reading, and writing

List of Practical

1. Computer Assisted + Activity Based Language Learning

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

2. Activity Based Language Learning

Practical 1: Presentation Skills: Orientation & Mock Session

Practical 2: Presentation Skills: Practice Practical 3: Group Discussions: Orientation & Mock Session Practical 4: Group Discussions: Practice Practical 5: Personal Interviews: Orientation & Mock Session Practical 6: Personal Interviews: Practice

Course Code	**Course Title**				**Category**
24ES03TH0205	**Fabrication Practices**				VESC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
1	0	1	50	50	1

Prerequisite: None.

Course Objectives:
1. Identify the different manufacturing processes 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: On successful completion of the module students will be able to:
After completing this course, students will be able to
CO1.Understand casting techniques for the production of casted components.
CO2.Identify an appropriate molding pattern and various carpentry joints.
CO3.Understand the machining parameters and cutting tools for various machining operations.
CO4. Distinguish between hot and cold working methods for the manufacturing of metal components.
CO5.Understand various fitting joints and sheet metal operations.
CO6. Apply the knowledge of suitable joining processes to carry out fabrication work.

UNIT I:	**09 Hrs.**
Introduction to foundries, metal casting, types of sand, introduction to moulding tools & different casting process.	
UNIT II:	**09 Hrs.**
Fundamentals of metal cutting, lathe machine specification and operations, metal cutting parameters, single point cutting tool	
UNIT III:	**9 Hrs.**
Fundamentals of metal cutting, Lathe machine specification and operations, metal cutting parameters, single point cutting tool	
UNIT IV:	**9 Hrs.**
Smithy and forging, hot working and cold working of metals, forging tools like chisels, hammers, types of furnaces	
UNIT V:	**9 Hrs.**
Fitting operations and associated measuring and marking tools, sheet metal operations.	

UNIT VI:
Metal Joining Process, Types of Welding, Mechanics of Welding, Soldering and Brazing

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 -EastWest PressPvt.Ltd.NewDelhi.

Course Code: 24ES04PR0204			**Course: Fabrication Practices Lab**
L: 0	**P: 2**	**S:1**	**Total Credits: 1**

Course Objectives:

The Objective of the course is:

1. To familiarize with major manufacturing process andr equired 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:
CO1.Prepare a sand mould for casting and perform pattern making.
CO2.Perform different machining operations on lathe machine and parts fitting job.
CO3. Apply the knowledge of joining processes to carry out fabrication work.

List of Experiments:

Introduction of tools, equipment, materials & processes along with demonstration and preparation of simple jobs 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

CaseStudy:

To prepare a 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 -EastWest Press Pvt. Ltd. NewDelhi.

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**
24HS02PR0106-01	**Liberal/Performing Art Courses** **Course: Fundamentals of Indian Classical Dance: Bharatnatayam**				CCA
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	24	24	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**
24HS02PR0106-**2**	**Liberal/Performing Art Courses** **Course: Fundamentals of Indian Classical Dance: Kathak**				CCA
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	24	24	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**
24HS02PR0106-**3**	**Liberal/Performing Art Courses** **Course: Introduction to Digital Photography**				CCA
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			

0	2	1	24	24	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.

Course outcome:
At the end of the course the students will be able to achieve the following:
1. Develop foundational skills in digital photography, including genres, camera handling, and settings.
2. Apply rules of composition and pre-visualization to create impactful photographs.
3. Master exposure control for creative and technical image-making.
4. Enhance photographs through post-processing techniques and portfolio development.
5. Present a professional-quality portfolio in a selected photography genre.

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.**

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**
24HS02PR0106-**8**	**Liberal/Performing Art Courses** **Course: Art of Painting**				CCA
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	24	24	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**
24HS02PR0106**-9**	**Liberal/Performing Art Courses** **Course: Art of Drawing**				CCA
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	24	24	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**
24HS02PR0106-**10**	**Liberal/Performing Art Courses** **Course: Nature Camp**				CCA
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	24	24	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**
24HS02PR0106-**11**	**Liberal/Performing Art Courses** **Course: Developing Self-awareness**				CCA
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	24	24	1

Prerequisite: None.

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

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

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

Syllabus:

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

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

Course Code	**Course Title**				**Category**
24HS02PR0106**-12**	**Liberal/Performing Art Courses** **Course: Art of Poetry**				CCA
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	24	24	1

Prerequisite: None.

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

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

Syllabus:

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

Reading material

I. The Art of Poetry
1. Fry, S. (2005). The ode less travelled: Unlocking the poetic mind. HarperCollins.
2. Addonizio, K., & Laux, D. (1997). The poet's companion: A guide to the pleasures of writing poetry. W.W. Norton & Company.
3. Lucy, J. (Ed.). (2001). The art of poetry. Penguin Books.
II. Understanding and Interpretation of Poetry
1. Hirsch, E. (1999). How to read a poem: And fall in love with poetry. Harcourt Brace & Company.
2. Pinsky, R. (1998). The sounds of poetry: A brief history. Farrar, Straus and Giroux.
3. Meyer, M. (2005). Poetry: An introduction. Bedford/St. Martin's.
III. Writing Poetry

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

Course Code	**Course Title**				**Category**
24HS02PR0106-**13**	**Liberal/Performing Art Courses** **Course: Creative and content writing**				CCA
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	24	24	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**
24HS02PR0106-**14**	**Liberal/Performing Art Courses** **Course: Science of life through Bhagwad Gita**				CCA
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	24	24	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**
24HS02PR0106-**1-1**	**Liberal/Performing Art Courses** **Course: Introduction to French Language**				CCA
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	24	24	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**
24HS02PR0106**-1-1**	**Liberal/Performing Art Courses** **Course: Introduction to Basic Japanese Language**				CCA
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	0	24	24	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)

SEMESTER - III

Course Code	Course Title				Category
24HS03TH0303	**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**
24ES04TH0302	**Thermodynamics**				PCC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	0	1	50	50	03
Prerequisite:					

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. CO5: Understand the basics of compressible fluid flow.	
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.	**9 Hrs.**
UNIT II: First Law of Thermodynamics	**9 Hrs.**
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.	
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 Steam 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: Air Standard Cycle Air Standard Cycles: Otto and Diesel cycle, Vapour Cycles: Simple and Modified Rankine cycle with reheat &regeneration, Binary cycle.	**7 Hrs.**
Unit VI: Compressible Flow Compressible Flow: Stagnation properties, Speed of sound wave, Mach number, one dimensional isentropic flow, Stagnation properties, Isentropic flow through convergent divergent nozzles.	**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.

Course Code	Course Title				Category
24ES04TH0303	**Manufacturing Engineering**				**PCC**
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
2	2	2	50	50	02

Prerequisite:

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.

Course Code	Course Title				Category
24HS01TH0302	**Material Science and Testing's**				PCC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
2	2	2	50	50	02

Prerequisite:

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

Course Outcomes: On successful completion of the module students will be able to:
CO 1. Understand the crystal structure, crystal imperfection, plastic deformation and strengthening mechanisms in crystalline solids.
CO 2. Compute the mechanical properties of engineering materials using various testing methods.
CO 3. Interpret and explain the cooling curves and phase diagrams of isomorphus, eutectic partial eutectic and layered systems.
CO 4. Interpret the Iron-Iron carbide equilibrium diagram, solidification and transformation of

slowly cooled steel, significance and general procedure of heat treatment processes. CO 5. Understand the composition, microstructure, properties and application of alloy steels, cast-iron and no ferrous metal alloys.	
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, critically resolved shear stress, strain hardening, yield point phenomenon, strain ageing, recovery recrystallization and grain growth. strengthening mechanisms, Diffusion	
UNIT II: Mechanical Properties Measurements Mechanical Property measurement: Tensile test - and engineering stress-strain curve, true stress-strain curve, relation between engineering and true stress-strain, necking, evaluation of properties. Compression test and Torsion test. Hardness test: Rockwell, Brinell and Vickers tests and their relation to strength. Impact tests: Izod and Charpy. Fatigue test: S-N curve, Creep test. Introduction to nondestructive testing (NDT)	**9 Hrs.**
UNIT III: Alloys, Solid Solutions Alloys, solid solutions, compounds, Hume-Rothery's rules of solid solubility, Gib's phase rule, Polymorphism. Solidification of pure metal, critical size of nucleus, shape of crystals, dendritic growth. Types of cooling curves, non-equilibrium cooling, coring. Equillibrium/ Phase diagrams: Plotting of equilibrium diagram, Lever rule, microstructure development; Isomorphus system, eutectic system, partial eutectic system, Layer type system, peritectic, peritectoid and monotectic reactions.	**9 Hrs.**
UNIT IV: Iron Carbon Phase Diagram Solidification of pure iron, Iron Iron-carbide phase diagram and microstrctural aspects of austenite, ferrite and cementite, pearlite and ledeburite. Critical temperatures, invariant reactions. Solidification and transformation of slowly cooled steel and cast-iron. Classification and specification of steel. Heat treatment of Steel, Transformation products of austenite. Isothermal transformation (TTT) diagrams for Fe-C alloys and microstructure development. Continuous cooling curves (CCT) and interpretation of final microstructures and properties. Annealing, tempering, normalizing and hardening. Austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening.	**9 Hrs.**
UNIT V: Alloying of Steel Alloying of steel, effect of alloying elements, classification, properties and uses of alloying elements. Alloy steels, stainless steels and tool steels. Cast irons; classification, factors influencing microstructure, grey, white, malleable and spheroidal cast irons. Copper and copper alloys; brass, bronze and cupro-nickel. Bearing Materials. Aluminium and Al-Cu – Mg alloys, Nickel based super alloys and Titanium alloys.	**9 Hrs.**
Unit VI: Introduction to Composite materials Introduction to Composite materials, Ceramics, Polymers, Smart materials.	**7 Hrs.**
TEXT BOOKS: Text Books: 1. W. D. Callister, 2006, "Materials Science and Engineering - An Introduction", 6thEdition, Wiley India. 2. V. D. Kodgire & S. V. Kodgire, Material Science and Metallurgy for Engineers, Everest Publishing House. 3. 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

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.

Course Code	Course Title				Category
24ES04TH0305	**Introduction to Python**				PCC
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
2	2	2	50	50	02 + 01

Prerequisite: Basic programming concepts/fundamentals

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 fundamental programming concepts such as data types, control structures, functions, and file handling to develop basic Python applications.

CO2. Design and implement modular Python programs using appropriate data structures like lists, tuples, dictionaries, and sets to solve real-world computational problems.

CO3. Demonstrate the ability to write, test, document, and manage Python code effectively using exception handling, unit testing, and basic version control tools.

CO4. Design and implement Strings, Lists, Tuples, Dictionaries, and Sets.

CO5. Demonstrate the ability to write, test, document, and manage File Handling and Exception Management.

UNIT I: Python Basics and Fundamentals	**05 Hrs.**

This unit introduces students to the Python programming environment, including installation of Python and the use of integrated development environments (IDEs) such as IDLE or Visual Studio Code. Students will learn about the basic syntax of Python, keywords, identifiers, and how to write simple Python programs. The unit also covers variables, data types, type casting, input and output functions, and the use of basic arithmetic and logical operators.	
UNIT II: Control Structures	**05 Hrs.**
This unit focuses on the fundamental control flow mechanisms in Python. Students will learn how to use conditional statements such as if, elif, and else to make decisions within programs. Additionally, the unit introduces loop structures including for and while loops, loop control statements like break, continue, and pass, and how these constructs are used to implement iteration and repetitive tasks.	
UNIT III: Functions and Modular Programming	**05 Hrs.**
In this unit, students will understand the concept of modular programming using functions. They will learn how to define and call functions, use parameters and return values, and understand variable scope (local and global variables). The unit emphasizes the importance of writing reusable and organized code through the creation of user-defined functions.	
UNIT IV: Data Structures – Strings, Lists, Tuples, Dictionaries, and Sets	**05 Hrs.**
This unit covers the built-in data structures in Python, including strings and their manipulation using built-in methods, as well as lists, tuples, dictionaries, and sets. Students will learn how to create, access, modify, and iterate through these data structures. Emphasis is placed on using appropriate data types for solving computational problems efficiently.	
UNIT V: File Handling and Exception Management	**05 Hrs.**
Students will be introduced to file operations in Python, including reading from and writing to text files, and working with structured data in formats like CSV. The unit also explores exception handling techniques using try, except, finally, and raise, helping students write more robust and error-resilient programs	
UNIT VI: Libraries, Data Handling, and Project Development	**05 Hrs.**
In the final unit, students are introduced to the use of Python libraries such as math, random, and datetime, followed by a basic introduction to numpy and pandas for simple data handling tasks. The unit concludes with the development of mini projects where students apply the knowledge and skills gained from previous units to design, implement, and demonstrate complete Python applications.	
TEXT BOOKS: [1] Eric Matthes, "Python Crash Course: A Hands-On, Project-Based Introduction to Programming", 3rd Edition, No Starch Press, 2023. [2] Reema Thareja, "Python Programming", Oxford University Press, 2017. [3] John M. Zelle, "Python Programming: An Introduction to Computer Science", 3rd Edition, Franklin, Beedle & Associates Inc., 2017.	
REFERENCE BOOKS: [1] Al Sweigart, "Automate the Boring Stuff with Python: Practical Programming for Total Beginners", 2nd Edition, No Starch Press, 2019. [2] Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Green Tea Press, 2015. [3] Mark Lutz, "Learning Python", 5th Edition, O'Reilly Media, 2013. [4] Luciano Ramalho, "Fluent Python: Clear, Concise, and Effective Programming", 2nd Edition, O'Reilly Media, 2022. [5] Brett Slatkin, "Effective Python: 90 Specific Ways to Write Better Python", 2nd Edition, Addison-Wesley, 2019. [6] Wesley J. Chun, "Core Python Programming", 2nd Edition, Prentice Hall, 2006.	

[7] Yashavant Kanetkar, "Let Us Python", BPB Publications, 2019.
[8] Gowrishankar S., Veena A., "Introduction to Python Programming", CRC Press, 2018.

LIST OF PRACTICAL ASSIGNMENTS:

1. Write a Python program to demonstrate input/output operations and use of variables and data types.
2. Write a Python program to perform arithmetic operations and apply logical and comparison operators.
3. Write a Python program that uses if-else conditions to determine whether a number is even or odd, or find the largest of three numbers.
4. Write a Python program to implement loops: print multiplication tables, factorial, and Fibonacci series using for and while loops.
5. Write user-defined functions to calculate the area of geometric shapes and demonstrate parameter passing and return values.
6. Write a Python program to manipulate strings using slicing, formatting, and string methods such as find, replace, and split.
7. Write a Python program to demonstrate list and tuple operations: creation, indexing, slicing, appending, and iteration.
8. Write a Python program using dictionaries and sets to store and process key-value pairs, and perform set operations.
9. Write a Python program to read from and write to a text file, and count the number of words or lines in the file.
10. Write a Python program that handles exceptions using try, except, and finally blocks to manage runtime errors.
11. Write a Python program that uses built-in libraries such as math, random, or datetime to solve basic computational problems.
12. Develop a mini project such as a contact book, quiz game, or file organizer using all concepts learned in the course.

Course Code	Course Title				Category
24ES04TH0301	**Machine Drawing and CAD Lab**				PCC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
1	2	2	50	50	1

Prerequisite: Theory of Mechanism and Elasticity

Course Objectives:

1. To develop an ability to construct assembly and disability of machine and its components
2. To develop an ability to create solid models of machine component and assembly

Course Outcomes:

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

1. Ability to select standard machine elements as per the standards
2. Ability to draw and read production drawings
3. Ability to use the drafting and design tools

4. Ability to model machine components using modelling tools 5. Ability to design CAD-Based Machine Drawing: **I**ntroduction to CAD tools like AutoCAD, CATIA, etc.
UNIT I: **09 Hrs.**
Conventional representations of standard machine elements like: Bolts, Nuts, Washers, Rivets, Keys and Couplings. Selection of standard machine elements. Thread terminology, Types of Threads and their representations. Machining Symbols.
UNIT II: **09 Hrs.**
Limits: Terminology Fits: Types and Applications of fits. Dimensional Tolerance, Geometrical Tolerance. Tolerance Grades and Tolerance Charts, calculations of dimensional tolerance.
UNIT III: **9 Hrs.**
Assembly Drawing: Introduction, Study of some Standard Assemblies based on actual machine components. Selection of machine component for assembly drawing. Subassembly Drawing, Full Assembly Drawing, Preparation of Bill of material. Production drawing preparation
UNIT IV: **9 Hrs.**
Part Drawing: Introduction, Study and selection of machine component for part drawing based on actual machine components. Part Drawing from Assembly by incorporating manufacturing considerations: machining allowances, tolerances, and surface finish.
UNIT V: **9 Hrs.**
CAD-Based Machine Drawing: **I**ntroduction to CAD tools like AutoCAD, CATIA, etc. Creating orthographic projections and part models. Dimensioning and tolerance application in CAD. Layers, blocks, hatching, and annotations. Importing and exporting technical drawings. Printing and plotting drawings
TEXT BOOKS: 1. Machine Drawing by N. D. Bhat, Charotar Publications 2. Machine Drawing by K. L. Narayan, R. Kannaiah, K.V.Reddy, New Age Int. Publishers 3. Machine Drawing by P. S. Gill, S. K. Kataria & Sons
REFERENCE BOOKS: 1. PSG Design Data Book by Kalaikathir Achchagam (PSG College of Technology, Coimbatore) 2. Engineering Drawing Practice for Schools & Colleges (SP-46:1988): Bureau of Indian Standards 3. Design Data For Machine Elements by B. D. Shiwalkar

Course Code	**Course Title**				**Category**
24ES04TH0304	**Design Thinking**				AEC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	50		1
Prerequisite:					

Course Outcomes: On successful completion of the module students will be able to: • Be familiar with processes and methods of creative problem solving: • Enhance their creative and innovative thinking skills • Practice thinking creatively and innovative design and development • Understand Systematic inventive thinking • Understand Introduction to design for interaction	
UNIT I: INTRODUCTION	**9 Hrs.**
Making a case for creativity, Creative thinking as a skill, valuing diversity in thinking: Thinking preferences, Creativity styles, Creativity in problem solving	
UNIT II: Pattern Breaking	**9 Hrs.**
Thinking differently, Lateral thinking, Mind stimulation: games, brain- twisters and puzzles, Idea-collection processes, Brainstorming/Brain writing, The SCAMPER methods, Metaphoric thinking, Outrageous thinking, Mapping thoughts, other (new approaches)	
UNIT III:	**9 Hrs.**
Using Math and Science, Systematic logical thinking, Using math concepts, Eight-Dimensional (8D) Approach to Ideation: Uniqueness, Dimensionality, Directionality, Consolidation, Segmentation, Modification, Similarity, and Experimentation **UNIT IV: Systematic Inventive Thinking**	**9 Hrs.**
Systematic inventive thinking: The TRIZ methodology, Decision and Evaluation: Focused thinking framework, six thinking hats, and Ethical considerations.	
UNIT V: Design for Innovation:	**9 Hrs.**
Introduction to design for interaction, nine lessons for innovation, difference in creativity and innovation, Building blocks for innovation	
UNIT6.IntellectualProperty: Introduction to intellectual property: Patents, Trademarks , Trade Secret, Unfair Competition	**9Hrs**
TEXT BOOKS: 1. Creative Problem Solving for Managers-Tony Proctor-Routledge Taylor &Francis Group 2. 101Activities for Teaching creativity and Problem Solving-By Arthur B. Vangundy-Pfeiffer 3. H .S. Fogler and S .E. LeBlanc, Strategies for Creative Problem Solving ,Prentice Hall 4. E. Lumsdaine and M. Lumsdaine, Creative Problem Solving, McGraw Hill,	
1. Creative Problem Solving for Managers-Tony Proctor-Routledge Taylor &Francis Group 2. 101Activities for Teaching creativity and Problem Solving-By Arthur B. Vangundy-Pfeiffer 3. H .S. Fogler and S .E. LeBlanc, Strategies for Creative Problem Solving ,Prentice Hall 4. E. Lumsdaine and M. Lumsdaine, Creative Problem Solving, McGraw Hill	

SEMESTER - IV

Course Code	Course Title				Category
24ES04TH0401	**Mechanics of Solids**				PCC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			

3	0	1	50	50	3

Prerequisite:

Course Objectives:
To satisfy functional and strength requirements of machine elements.

Course Outcomes: On successful completion of the module students will be able to:
CO1: Determine the bending stresses, shear stresses, slope and deflection in beams.
CO2: Understand the concept of torsional shear failure of circular shaft and evaluate the stresses subjected to torsional loads. Also decide the dimensions of columns and struts for its stability.
CO3: Analyze cylinders, spherical shells and rotating discs.
CO4: Design of various temporary and permanent joints for various applications.
CO5: Determine the safe dimensions of Power screw and mechanical springs.

UNIT I: **8 Hrs.**

Bending and shear stresses in beams : Theory of simple bending, significance of moment of inertia, beam of uniform strength, variation of shear stress in different section of beam.
Slope and deflection of beams: Beam differential equation, determination of slope and deflection by various methods i.e. double integration method, Macaulay's method, Moment-area method, Castiglione's theorem. Introduction to Maxwell's reciprocal deflection theorem and Betti's theorem of reciprocal deflection.

UNIT II: **8 Hrs.**

Torsion of circular shaft: Theory of torsion, significance of polar moment of inertia, Torsion of tapered shaft, strain energy in torsion, combined bending and torsion.
Column and strut: Euler's theory of column, concept of equivalent length, slenderness ratio and radius of gyration, Rankine's formula.

UNIT III: **8 Hrs.**

Cylinders and rotating disc: Theory of thin and thick cylinders, hoop and circumferential stresses developed in thin cylinders, stresses developed in thin rotating ring (flywheel) and disc of uniform thickness

UNIT IV: **7 Hrs.**

Design of joints:
Temporary and permanent joints, Cotter joint, knuckle joint, bolted, riveted and welded joint for axial and eccentric loading.

UNIT V: **7 Hrs**

Design of mechanical springs: Classification and application of springs, design of closed coil helical springs, springs in series and parallel, design of leaf spring for automotive applications.
Design of Power Screw: Terminology of power screw, types of power screw, Design of screw and toggle jack. Simple applications of power screw.

UNIT VI: **7 Hrs.**

Design of Brakes: Requirement, Kinematics of friction drives, Design of Block brake, band brake, band and block brake, internal expanding shoe brake.
Design of Clutches: Positive and friction Clutches, Material for Friction Surfaces, Single Disc or Plate Clutch, Multiple Disc Clutch, Cone Clutch, Centrifugal Clutch. Recent advancement of clutches in automotive sector.

TEXT BOOKS:

1. Strength of Materials by S.S. Rattan, McGraw-Hills Education (India) Publication, India.

2. Strength of Materials by S.S. Bhavikatti, Vikas Publishing house, Noida, India.
3. Design of Machine Elements by V. B. Bhandari, Tata Mc-Graw Hill publications.

REFERENCE BOOKS:

1. Strength of Materials by F. L. Singer, Harper and row Publication.
2. Engineering Mechanics of Solid by Egor P. Popov, Prentice Hall of India Publication.
3. Machine Design: An integrated approach by Robert L. Norton, Prentice Hall, Pearson publication.
4. Design Data: Data Book of Engineers by PSG College-Kalaikathir Achchagam - Coimbatore

Course Code	Course Title				Category
24ES04TH0401	**Kinematics and Dynamics of Machinery**				PCC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	2	2	50	50	03

Prerequisite: NA

Course Objectives:

1. To cover the kinematics and dynamics of planar single degree of freedom mechanisms,
2. To develop skills for designing and analyzing linkages, cams, gears and other mechanisms.
3. To provide a foundation for the study of Machine Design course.

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

CO1. Determine the displacement, velocity and acceleration at any point in a rigid link of a given mechanism.
CO2. Demonstrate the understanding of successfully addressing issues related to kinematics of Spur gears and gear trains.
CO3. Demonstrate the gyroscopic effect on airplane, ship, four-wheeler and two-wheelers.
CO4. Examine the balancing of the rotating and reciprocating elements to avoid the failure.
CO5. Analyze the free and forced vibrations in simple mechanical systems.

UNIT I: Kinematic Analysis of Mechanisms	**9 Hrs.**
Displacement, velocity and acceleration analysis of simple mechanisms, kinematic analysis of simple mechanisms- slider crank mechanism, coincident points- Coriolis component of acceleration	
UNIT II: Kinematics of Gear and Gear Trains	**9 Hrs.**
Involute and cycloidal gear tooth profiles, gear terminologies, fundamental law of gearing and conjugate action, spur gear, length of path of contact, length of arc of contact, contact ratio and interference/undercutting, kinematics of regular and epicyclic gear trains	
UNIT III: Gyroscopic Motion	**9 Hrs.**
Rigid body motion in space, Euler's equation of motion, simple precession and gyroscopic couple, gyroscopic effect on airplane, ship, four-wheeler and grinding mills	
UNIT IV: Balancing of Rotary and Reciprocating Masses	**9 Hrs.**
Inertia forces and their balancing for rotating and reciprocating machines, static & dynamic balancing in rotating machines, balancing by vector diagram, balancing of different masses rotating in different planes, Partial balancing of reciprocate masses, balancing of multi cylinder inline engines	
UNIT V: Vibrations of Simple Mechanical Systems	**9 Hrs.**

Derivation of equation of motion for vibratory system, free vibration of single-degree of freedom system with and without damping. Logarithmic decrement and damping estimation, Forced vibration of single degree of freedom and vibration isolation, whirling speed of shaft, Vibration absorbers, Torsional oscillations of two-disc and three-disc rotors, with varying cross-section and gear ratio.
TEXT BOOKS: [1] Theory of Machines: S.S. Rattan, Tata McGraw Hill Publishers, 3rd edition onwards
REFERENCE BOOKS: [1] Kinematics & Dynamics of Machinery: R. L. Norton Tata McGraw Hill Publishers [2] Mechanism and Machine Theory: J. S. Rao & Rao V. Dukkipati, New Age International [3] Theory of Mechanisms and Machines: Ghosh& Mallik, Tata McGraw Hill [4] Theory of Machines: Thoman Bevan, CBS publication [5] Theory of Machines and Mechanisms: Uicker and Shigley, Tata McGraw Hill

Course Code	**Course Title**				**Category**
24ES04PR042	**Kinematics and Dynamics of Machinery Lab**				PCC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	50	00	1

Prerequisite:

Course Objectives:
To exemplify concepts of gyroscopic effects, static and dynamic mass balancing and to teach linear vibration analysis of one and two degree of freedom rigid body systems.

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

CO1. Demonstrate the effect of gyroscopic couple on an airplane, ship, four wheelers and two wheelers.
CO2. Determine the frequency of Longitudinal, Transverse and Torsional vibrations.
CO3. Understand the effects of jumping phenomenon in cams and whirling speed of a shaft.
CO4. Understand and examine the balancing of the rotating and reciprocating elements to avoid the failure of machine components.
CO5. Understand and examine the Free Torsional vibrations of two rotor system

Sr. No.	List of Practical
1	Simple and Compound Pendulum
2	Bi-filar Suspension
3	Motorized Gyroscope
4	Cam Dynamics
5	Whirling of Shaft
6	Balancing of Rotary Masses
7	Balancing of a Single Reciprocating Mass

	8	Natural Vibrations of a spring mass system	
	9	Free Vibrations of an equivalent spring mass system	
	10	Forced Vibrations of an equivalent spring mass system	
	11	Free Torsional vibrations of single rotor system	
	12	Free Torsional vibrations of two rotor system	

Course Code	**Course Title**				**Category**
24ES04TH0403	**Fluid Mechanics and Hydraulic machines**				PCC
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
3	2	2	50	50	3

Prerequisite: Basics knowledge of fluids dynamics.

Course Objectives:
1. To understand the fluids and dynamics of fluids using concepts of continuity equation.
2. To study the fundamentals of basic fluid machines used in practice.

Course Outcomes: On successful completion of the module students will be able to:
The students will be able
CO1 :To understand basic principles of fluid dynamics.
CO2 : To identify various flows and to estimate the head losses for flow through pipes & apply boundary layer concepts.
CO3: To understand effect of hydrodynamic forces on various types of vanes.
CO4:To apply knowledge to evaluate performance of hydraulic turbines.
CO5:To analyze functioning & characteristics of centrifugal and reciprocating pump.

UNIT I: Introduction to fluid mechanics	**8 Hrs.**
Kinematics & Dynamics of Fluid Flow: Linear Momentum Equation. Euler's equation, Bernoulli's equation. Applications of Bernoulli's equation Venturimeter, Orifice, Pitot tube. (Numericals):	

UNIT II: Viscous Flow	**8 Hrs.**
Introduction to laminar and turbulent flow, Reynolds number and its Significance. Flow of viscous fluids through pipe. Boundary layer Boundary Layer Concepts: Definition, thicknesses, characteristics along thin plate, laminar and turbulent boundary layers (No derivation). Flow Through Pipes: Losses in pipes. Pipes in series and parallel. Dimensional analysis: Buckingham's π- theorem (Numericals).	

UNIT III: Basics of turbo machinery	**8 Hrs.**
Impact of jet and jet propulsion: Momentum 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: Classification of water 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: Theory of Rotodynamic 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 NPSH – (net positive suction head),priming,cavitation in pumps, Reciprocating pump – working principle	
UNIT VI: Hydraulic Machines	**7 Hrs.**
Hydraulic press, hydraulic accumulator, hydraulic intensifier, hydraulic crane, hydraulic jack, hydraulic lift, hydraulic ram, fluid couplings, fluid torque converter and air lift pump.	
TEXT BOOKS: 1. Fluid Mechanics & Machines: R. K. Bansal- Laxmi publications. 2. A text book of Fluid Mechanics : R.K. Rajput, S.Chand Publication. 3.Fluid Mechanics & Fluid Power Engineering: D. S. Kumar -S. K. Kataria Publications	

Course Code	**Course Title**				**Category**
24ES04PR0403	**Fluid Mechanics and Hydraulic machines Lab**				PCC
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
0	2	1	50	00	1

Prerequisite: Basics knowledge of fluids dynamics.

Course Objectives:
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. 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:Use knowledge of various discharge measuring devices such as orifice, mouthpiece and venturimeter for determining Cd, Cc, Cv.
CO2. Determine the major and minor losses in the various pipes
CO3. Graphically present the output of Impulse and Reaction turbines
CO4. Ability to perform practicals of rotodyanamic pump and positive displacement pump
CO5. Ability to perform practicals of minor losses in pipe flow

The laboratory will have minimum Eight Practical :

Expt 1. Determination of coefficient of discharge for Venturi meter
Expt 2. Determination of coefficient of discharge for Orifice meter
Expt 3. Determination of hydraulic coefficients C and C for orifice dc
Expt 4. Determination of hydraulic coefficients C and C for mouthpiece dc
Expt 5. Determination of Darcy Friction factors for different pipes
Expt 6. To calculate efficiency of Pelton turbine
Expt 7. To calculate efficiency of Francis turbine
Expt 8. To calculate efficiency of Centrifugal pump

Expt 9. To calculate efficiency of Reciprocating pump
Expt 10. To determine minor losses in pipe flow

Course Code	Course Title				Category
24ES04TH04	**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 various components.
2 Develop conceptual understanding of tolerance systems and design assembly gauges.
3 Interpret different production operations and prepare the tolerance chart.
4 Develop and apply knowledge of engineering metrology and measuring equipment's.
5 Analyze and interpret technical data through Quality Control techniques.

UNIT I: Die and Mold Design	**9 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.

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.

UNIT III: Process Planning	**9 Hrs.**

Interpretation and significance of process planning, steps in process planning, preparation of tolerance chart, classification of operations, sequencing of operations, selective assembly, interchangeability.

UNIT IV: Metrology	**8 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 V: Quality and quality control	**8 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 – VI: Acceptance sampling for inspections **8 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
24ES04PR0404	**Manufacturing Technology Lab**				PCC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	50	00	1

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

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:

Expt 1. Measurement of linear dimensions with Vernier Caliper.
Expt 2. Measurement of linear dimensions with Vernier height gauge & depth gauge.
Expt 3. Measurement of linear dimensions with Micrometer screw gauge.

Expt 4. Measurement of angular dimensions with bevel protector.
Expt 5. Measurement of angular dimensions with sine bar and slip gauges.
Expt 6. Measurement of straightness with Autocollimator.
Expt 7. Study and use of Optical flat.
Expt 8. Measurement of screw dimensions using Tool Maker's Microscope.
Expt 9. Measurement of screw dimensions using Profile projector.
Expt 10. Case study: To study in detail the power presses.
Expt 11. Case study. To learn from case studies on design of assembly fits & limits gauges
Expt 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
24ES04PR0405	**Project-1(Mini Project)**				CEP/FP
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
0	2	2	50	00	1

Prerequisite:

Course Objectives:

1. Introduce students to the basics of engineering problem-solving and product development.
2. Foster creativity, curiosity, and innovation using simple engineering principles.
3. Enable hands-on experience with low-risk, low-cost implementations.
4. Develop teamwork, technical documentation, and presentation skills.

Course Outcomes: On successful completion of the module students will be able to:
CO1: Identify and define a small-scale mechanical engineering problem.
CO2: Design a simple solution using modeling or prototyping.
CO3: Demonstrate technical communication through seminar presentations.
CO4: develop 2D/3D CAD modeling or concept sketches.

Seminar	Title	Objective
Seminar 1	Topic Selection & Planning	Identify the problem, define scope and expected outcomes.
Seminar 2	Implementation & Review	Demonstrate progress with methodology or partial model.
Seminar 3	Completion & Reflection	Present the final outcome with reflection on learning and future scope.

Syllabus

1. Idea Generation and Selection – Brainstorming, identifying real-world micro-problems.
2. Design Phase – 2D/3D CAD modeling or concept sketches.
3. Material Selection & Basic Fabrication – Use of locally available/low-cost materials.
4. Testing/Validation – Performance check under basic parameters.
5. Presentation & Reporting – Technical writing and oral communication.

Course Code	Course Title				Category
24HS01TH0401	**Environmental Science**				VEC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
1	2	1	50	00	1

Prerequisite:

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

SEMESTER - V

Course Code	**Course Title**				**Category**
24ES04TP0501	**Robotics and Mechatronics**				PCC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	2	2	50	50	3

Prerequisite: Kinematics and Dynamics of Machinery

Course Objectives:
This course aims to provide a comprehensive understanding of the integration of mechanical, electrical, and control systems in robotic and automated systems. It focuses on developing practical skills in designing, analyzing, and implementing mechatronic systems for real-world applications.

Course outcomes
At the end of this course students will be able to:
CO1. Understand the fundamentals of robotic technology.
CO2. Perform the forward and inverse kinematics of n-DOF robot for trajectory planning.
CO3. Understand the functions and applications of various actuators used in robots.
CO4. Develop and implement microcontroller-based solutions,
CO5. Hands-on experience in PLC programming using Ladder logic.

Unit- I: Introduction to Robotics: **10 Hrs.**

Definition and evolution of robot, Need for Robots & its applications, Anatomy and classification of robots, what is and what is not a robot, progressive advancements in robots. Co-ordinate Systems,

Specifications of robot, Pitch, Yaw, Roll, Laws of robot. End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers.

Unit- II: Kinematics and Dynamics of Robot:	**10 Hrs.**

Kinematics of serial robots Coordinate frame, mapping and transformation, Forward & inverse kinematics, Representation of joints, link representation using D-H parameters, Examples of D-H parameters and link transforms. Introduction to trajectory planning and dynamics of robots.

Unit-III: Actuators in Robots	**10 Hrs.**

Elements of electromechanical energy conversion, DC & AC motors, Different types of stepper motors, hold on torques and position control of stepper motors. Starting, inversion and control of electrical drives, coupling of mechanical loads to DC and AC electrical drives. Pneumatic and Hydraulic systems, Process control valves, Rotary actuators, Mechanical Actuation systems. Piezoelectric actuators.

Unit-IV: Signals and Control in Robots	**10 Hrs.**

Signal Conditioning, Amplification, Protection, Filtering, Bridge Circuits, Comparator, Digital signals, Introduction to digital system Processing, Pulse Modulation. Data Acquisition and Controlling, Microcontrollers and PLCs programming (Ladder), direction and speed control of electric motors, PID controls.

Text Books:

1. R. K. Mittal, I. J. Nagrath, "Robotics and Control", McGraw Hill Education, 2017.

Reference Books:

1. Craig. J. J., "Introduction to Robotics- mechanics and control", Addison- Wesley, 1999.

Course Code	**Course Title**				**Category**
24ES04TH0502	**Design of Machine Elements**				PCC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	2	2	50	50	4

Prerequisite: Introduction to Machine Element Design

Definition of Machine Design, types of Machine Design, Basic procedure of design process Overview of machine elements and their significance in engineering design. selection of material, preferred number. Aesthetic and ergonomic considerations in design. Basic terminology, design considerations, and factors influencing machine element design.

Course Objectives:

The objective of the course is to prepare the students:

1. To develop a comprehensive understanding of the fundamental concepts underlying the design of machine elements
2. To familiarize students with the principles of selecting appropriate materials and manufacturing processes for machine components.
3. To equip students with practical experience with design calculations, simulation tools, and relevant case studies.

Course outcomes

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

CO1. Apply design principles for mechanical components subjected to dynamic loading.
CO2. Design the shaft and keys based on different criteria.
CO3. Apply the design considerations for both rigid and flexible couplings.
CO4. Apply appropriate selection criteria to select suitable bearings to meet performance, reliability, and durability standards.
CO5. Apply the design principles and analyze the mechanical drives.

UNIT I: Design against static and dynamic load	**9 Hrs.**

Theories of static failure, Stress concentration etc. Overview of fatigue phenomena and its significance in engineering design, stress concentration factors, and notch sensitivity, S-N curves, Fluctuating stresses, Fatigue failure, Soderberg and Goodman criterion, Design of mechanical components subjected to dynamic loading for finite and infinite life.

UNIT II: Design of transmission Shaft and Keys	**9 Hrs.**

Design of shaft on the Basis of Strength, rigidity and critical speed. ASME Code for shaft Design, Design of splines and keys.

UNIT III: Design of Rigid and Flexible Couplings	**9 Hrs.**

Types of couplings and their applications. Design considerations for rigid and flexible couplings. Analysis of torque transmission, misalignment compensation, and vibration damping.

UNIT IV: Design of Rolling Contact and Sliding Contact Bearings	**9 Hrs.**

Principles of operation and classification of rolling contact bearings. Bearing life calculations, load ratings, and selection criteria.
Principles of lubrication and friction in sliding contact bearings. Types of sliding contact bearings and their design considerations. Bearing materials, surface finish, and lubrication regimes.

UNIT V: Design of power transmission drives	**9 Hrs.**

Gear types, terminology, and classifications. Gear tooth geometry, strength analysis, and design calculations. Gear materials, lubrication, and efficiency considerations. Design of Gears (Beam strength and wear criterion, AGMA method)
Chain drives: types, selection criteria, and design considerations. Belt drives: types, pulley design, and tensioning systems. Power transmission efficiency, wear analysis, and maintenance practices.

Text Books:

1. Bhandari V.B., Design of Machine Elements, Tata Mc-Graw Hill publications.
2. Machine Design" by Robert L. Norton
3. Data, Design. "Data Book of Engineers by PSG College." Kalaikathir Achchagam, Coimbatore. (PSG Design Data Book.)

Reference Books:

1. Bhandari V.B., Design of Machine Elements, Tata Mc-Graw Hill publications.
2. Machine Design" by Robert L. Norton
3. Data, Design. "Data Book of Engineers by PSG College." Kalaikathir Achchagam, Coimbatore. (PSG Design Data Book.)

Course Code	Course Title	Category

24ES04PR0502	**Design of Machine Elements Lab**				PCC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	24	24	1

Prerequisite: Engineering Mechanics,

Course Objectives

The objective of the course is to prepare the students:

1. To help students understand the basics of machine element design, material selection, and manufacturing methods.
2. To train students in using design calculations and tools through hands-on practice and case studies.

Course outcomes

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

1. To learn how to design shafts and keys using strength calculations and CAD tools.
2. To understand the design and modeling of rigid and flexible couplings, including stress and material selection.
3. To select and design rolling and sliding bearings based on load and life, and create their assemblies using CAD.
4. To design belt, chain and gear drives, and simulate their operation using engineering software.
5. To Demonstrate functioning of different drive systems

EXPT 1. DESIGN OF TRANSMISSION SHAFT AND KEYS

Practical Activities:

- Experiment: Determine torsional strength of circular shafts
- CAD Task: Create a detailed 3D CAD model of a stepped shaft with appropriate keyways and fillets.
- Design Exercise: Manual and CAD-based design of a transmission shaft subjected to bending and torsional loads, including selection of shaft material and factor of safety.
- Key Design Task: Select and dimension parallel and taper keys based on shaft and hub dimensions.

Software Tools: SolidWorks / AutoCAD + Excel for calculations

EXPT 2. DESIGN OF RIGID AND FLEXIBLE COUPLINGS

Practical Activities:

- CAD Modeling: Create 3D models of rigid flange coupling and flexible bush-pin coupling with detailed dimensions.
- Design Calculation: Calculate stresses in coupling bolts, flange hub, and keys under torque transmission.
- Workshop Demo (if available): Assembly/disassembly of real couplings or 3D printed models.
- Material Selection Task: Choose suitable materials for flexible elements in couplings (e.g., rubber, leather, nylon).

Software Tools: SolidWorks/Creo for modeling, Excel or MATLAB for calculations

EXPT 3. DESIGN OF ROLLING CONTACT AND SLIDING CONTACT BEARINGS

Practical Activities:

- Bearing Selection Task: Choose appropriate rolling contact bearing (ball or roller) from manufacturer catalog (e.g., SKF) based on load and life calculations.
- Design Sheet: Calculate static and dynamic load capacities, equivalent loads, and bearing life.
- CAD/Assembly Task: Create exploded view and assembly of bearing with shaft and housing.
- Sliding Bearing Lab Demo: Understand journal bearing characteristics using a tribology test setup or simulation.

Software Tools: Excel + Bearing catalog + SolidWorks/FreeCAD for assemblies

EXPT 4. DESIGN OF POWER TRANSMISSION DRIVES

Practical Activities:

- Design Exercise: Design a belt drive and chain drive for specified power and speed ratio. Include calculation of belt tension, length, and pulley dimensions.
- Gear Design Task: Involute gear profile generation and strength analysis for spur or helical gears.
- CAD Modeling: 3D models of V-belt, chain drive, and gear systems including tensioners/idlers.
- Dynamic Simulation (Optional): Simulate gear or belt drive in software like Simscape, ADAMS, or Fusion 360 Motion.
- Workshop Demo: Demonstrate functioning of different drive systems (models or kits).

Software Tools: SolidWorks / Inventor / Excel / GearTribe or MITCalc

Text Books:

1. Bhandari V.B., Design of Machine Elements, Tata Mc-Graw Hill publications.
2. Machine Design" by Robert L. Norton
3. Data, Design. "Data Book of Engineers by PSG College." Kalaikathir Achchagam, Coimbatore. (PSG Design Data Book.)

Reference Books:

1. Bhandari V.B., Design of Machine Elements, Tata Mc-Graw Hill publications.
2. Machine Design" by Robert L. Norton
3. Data, Design. "Data Book of Engineers by PSG College." Kalaikathir Achchagam, Coimbatore. (PSG Design Data Book.)

Course Code	Course Title				Category
24ES04TH0501	**Heat Transfer**				PCC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	2	2	50	50	3

Prerequisite: Thermodynamics

Course Objectives:

The objective of the course is to prepare the students:

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

Course outcomes

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

CO1. Understand and analyze basic modes of heat transfer and apply mathematical equations to
CO2. analyse steady state heat conduction.
CO3. Analyze heat conduction with internal heat generation, extended surfaces and unsteady state heat transfer.
CO4. Demonstrate the concept and mechanism of forced convection for flow over flat plate, external, internal flows through conduits.
CO5. Understand the concept of natural convection, boiling and condensation.

UNIT I: Basic modes of Heat Transfer	**09 Hrs.**

Introduction, Basic modes of Heat Transfer, Conduction, Convection and Radiation, Laws of Heat Transfer, General Heat conduction equation in Cartesian Coordinates, Thermal conductivity and diffusivity, One dimensional steady state conduction equation for the plane wall, Cylinder and Sphere, Thermal resistance of composite structures, Contact resistance, overall heat transfer coefficient, critical thickness of insulation.

UNIT II: Heat Conduction	**09 Hrs.**

Conduction with internal heat generation for plane wall, Cylinder and sphere, Extended Surfaces, Types of Fins, Fins of uniform cross section area, temperature distribution and their heat transfer rate, Fin efficiency and effectiveness, Unsteady state Heat transfer, Lumped Heat Capacity analysis, Heisler charts, Biot number, Fourier number and their significance.

UNIT III: Forced convection	**9 Hrs.**

Forced convection, physical significance of non-dimensional parameters, Flow of high, moderate and low Prandtl number fluid over flat surface, Concept of velocity and thermal boundary layer thickness, Local and average Heat Transfer coefficient, empirical co-relation for external, internal flow, Laminar and turbulent flow through conduits.

UNIT IV: Free or Natural Convection	**9 Hrs.**

Free or Natural Convection, Grashoff number, Rayleigh number, horizontal and vertical plate, empirical correlations for Cylinders and sphere, Heat transfer with phase change, pool boiling curve and regimes of pool boiling, film and drop wise condensation, Laminar film condensation on vertical surface, Film condensation on horizontal tubes

UNIT V: Thermal radiation	**08 Hrs.**

Radiation, nature of thermal radiation, black body radiation, radiation intensity, laws of radiation-Kirchoffs, Planks, Weins displacement, Stefen-Boltzmann and Lamberts Cosine law, Emissivity, absorptivity, transmissivity, reflectivity, radiosity, emissive power, irradiation, Radiation network, radiation exchange between surfaces, idea of shape factor and reciprocity theorem, radiation between parallel plates, Cylinder and sphere, radiation shields, effect of radiation on temperature measurement.

UNIT – VI: Heat exchanger	**08 Hrs.**

Heat exchanger : classification, overall heat transfer coefficient, Fouling factor, LMTD method of heat exchanger analysis, Analysis for parallel, counter flow and cross flow arrangement, effectiveness-NTU method, heat exchanger analysis by NTU method

Text Books:

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

Reference Books:

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

Course Code	Course Title				Category
24ES04PR0501	**Heat Transfer Lab**				PCC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	2	1	50	0	1

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

Course Objectives

The objective of the course is to prepare the students:

1 To analyse steady state conduction heat transfer in various geometries.
2. To analyse natural and forced convention in various arrangements.
3. To understand radiation heat transfer in different geometries.
4. To analyse the performance of heat exchangers.

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 equipment's 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:

Expt 1. List of Experiments
Expt 2. To determine thermal conductivity of composite wall.
Expt 3. To determine thermal conductivity of insulating powder.
Expt 4. To determine thermal conductivity of lagging material.
Expt 5. To determine thermal conductivity of metal rod.
Expt 6. To determine the critical heat flux.
Expt 7. To determine heat transfer coefficient in natural convection.
Expt 8. To determine heat transfer coefficient in forced convection.
Expt 9. To determine heat transfer coefficient for a pin fin in natural and forced convection.
Expt 10. To determine effectiveness of heat pipe.
Expt 11. To determine emissivity of a test plate.
Expt 12. To determine Stefan Boltzman constant
Expt 13. To determine the effectiveness of a concentric tube heat exchanger

Course Code	Course Title	Category

24ES04TP0504	**Instrumentation and controls**				Core
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	2	2	50	0	3

Prerequisite: Physics and basics of Electrical Engineering.

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

Course Outcomes: On successful completion of the module students will be able to:
CO1. Understand measurement systems, identify the characteristics of instruments and explore different types of transducers & sensors with their working principle.
CO2. Understand the principles of operation of different sensors with their advantages and application
CO3. Analyse measurement and to use software & hardware for acquisition of data.
CO4. Understand fundamentals of control system and control system representation through Block Diagram and Signal Flow Graph.
CO5. Understand the modelling of various Physical, mechanical, electrical systems.

UNIT I: INTRODUCTION	**9 Hrs.**

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

UNIT II: TRANSDUCER AND THEIR TYPES	**9 Hrs.**

Sensors for displacement, velocity (Speed), acceleration, force, torque, vibration, pressure, temperature flow, liquid level and viscosity measurement.

UNIT III: DATA AQUISTION SYSTEM	**9 Hrs.**

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

UNIT IV: INTRODUCTION TO CONTROL SYSTEM	**9 Hrs.**

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

UNIT V: MODELLING OF SYSTEMS	**9 Hrs.**

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

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

REFERENCE BOOKS:

[1] Alan S. Morris, Principles of Measurement and Instrumentation, Prentice Hall of India
[2] K. Sawhney, Mechanical measurement and instrumentation, Dhanpat Rai & Company.
[3] Ernest O. Doebelin, Measurement systems Application and Design, Tata McGraw Hill Edition.
[4] Kuo B.C., Automatic control system, PHI Publications.

LIST OF PRACTICAL ASSIGNMENTS: lab course

1. Calibration of Pressure Gauges Using Dead Weight Pressure Gauge Tester
2. Angular Displacement Measurement Using Variable Capacitive Transducer
3. Linear Displacement Measurement Using Inductive Pick Up
4. Force Measurement Using Load Cell
5. Speed Measurement Using Inductive and Optical Transducer
6. Pressure Measurement Using Piezo-Resistive Pressure Sensor
7. Displacement Measurement Using LVDT.
8. Pressure Measurement Using Bourdon Tube 'C' Type With LVDT
9. Vibrations Measurement Using Piezo-Resistive Transducer
10. Light Intensity Measurement Using LDR
11. Torque Measurement Using Strain Gauges and Cantilever Jig
12. Strain/Force Measurement Using Strain Gauge Mounted on Cantilever Beam
13. Temperature Measurement Using Radiation Pyrometer
14. Humidity Measurement Using Capacitive Transducer For 90% R H Non Condensed
15. Measurement of Speed Of Wind Using Digital Anemometer
16. Introduction to Sound and vibration suit with portable DAQ.

Course Code	Course Title				Category
24ESPSE04TH0505-2	**Automotive power trains**				PSE
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	0	2	50	50	3

Prerequisite: Kinematics and Dynamics.

Course Objectives:

1. Understand conventional and next-gen powertrain technologies.
2. Gain insights into hybrid, electric, and alternative fuel powertrains. Analyze real-world case studies and industry trends.

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

1 To understand the fundamental concepts of automotive powertrain components.
2 To understand conventional internal combustion system for powertrains
3 To analyze conventional and modern transmission systems.
4 To explore and understand electric and hybrid powertrains.
5 To explore the latest advancements and future trends in the automotive industry.

UNIT I: Fundamentals of Automotive Powertrain	**09 Hrs.**

Overview of powertrain systems: IC engines, hybrid, and electric powertrains, Classification of powertrains based on energy source and transmission, Historical evolution of powertrains: From ICE to EVs and hydrogen-powered vehicles, Engine configurations: Inline, V-type, Boxer, Rotary (Wankel), Shift from IC engines to electric and alternative fuels.	
UNIT II: Internal Combustion Engine Powertrain	**9 Hrs.**
Components & working: Engine, clutch, transmission, driveshaft, differential, axle. Advanced IC engine technologies: Turbocharging, supercharging, direct injection, VVT, Emission norms and their impact on powertrain design (BS-VI, Euro 7), Alternative fuels: Hydrogen IC engines, biofuels, synthetic fuels.	
UNIT III: Transmission Systems	**9 Hrs.**
Manual transmissions: Types, gear ratios, synchronized vs. non-synchronized, Automatic transmissions: CVT, DCT, AMT, Torque Converter-based AT, Emerging technologies: Intelligent Manual Transmission (iMT), Shift-by-wire technology, Drivetrain configurations: FWD, RWD, AWD, and 4WD, Magnetorheological clutches, e-Axles, AI-based transmission control.	
UNIT IV: Hybrid & Electric Powertrains	**9 Hrs.**
Types of hybrid powertrains: Micro, mild, full, plug-in hybrid (PHEV), Components of hybrid vehicles: Engine, battery, motor, regenerative braking, Electric Powertrains: EV architectures (BEV, REEV, FCEV), Battery Management System (BMS), Battery technologies: Lithium-ion, Solid-state, Sodium-ion, Hydrogen fuel cells, Challenges in EV powertrain: Thermal management, charging infrastructure, energy efficiency.	
UNIT V: Future Trends in Automotive Powertrains	**9 Hrs.**
Software-defined powertrains: AI & ML in powertrain optimization, Advanced Thermal Management Systems for better efficiency, Wireless charging and bidirectional power transfer (V2G, V2H), Role of IoT & Cloud Connectivity in powertrain monitoring, 3D-printed and composite material-based powertrain components.	
Text Books: 1. John B. Heywood – Internal Combustion Engine Fundamentals. 2. V.Ganeshan : Internal Combustion engines 3. Thomas D. Gillespie – Fundamentals of Vehicle Dynamics	
Reference Books: 1. Ronald K. Jurgen – Hybrid and Electric Vehicles. 2. SAE & IEEE Journals on Automotive Powertrains & Future Mobility. 3. Kripal Singh : Automobile Engineering	

Course Code	**Course Title**				**Category**
24ESPSE04TH0505-7	**Machine Learning for Mechanical Engineering**				PSE
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	0	2	50	50	3
Prerequisite: Introduction to Python					

Course Objectives:
1. To equip students with machine learning concepts and their applications in mechanical engineering.
2. To learn data preprocessing techniques, supervised and unsupervised learning models, and deep learning approaches for mechanical systems.

Course outcomes : At the end of this course students will be able to:
1. Understand the fundamentals of machine learning and its relevance in mechanical engineering applications.
2. Pre-process and analyze mechanical data, including sensor signals, vibration patterns, and thermal imaging, for feature extraction and model building.
3. Develop and implement supervised and unsupervised learning models for predictive maintenance, fault detection, and quality assessment.
4. Apply deep learning techniques such as CNN and RNN for advanced applications like image-based defect detection and time-series forecasting.
5. Utilize AI-driven optimization techniques and ML models to enhance design processes, manufacturing efficiency, and predictive maintenance strategies.

Unit 1: Introduction to Machine Learning & Applications in Mechanical Engineering	**8Hrs.**

Basics of AI and ML, Types of Machine Learning (Supervised, Unsupervised, Reinforcement Learning), Data-driven decision-making, ML applications in Mechanical Engineering (Predictive Maintenance, Quality Control, Design Optimization, Manufacturing Process Automation), Introduction to Python for ML, Popular ML Libraries (Scikit-learn, Tensor Flow, Keras).

Unit 2: Data Preprocessing & Feature Engineering for Mechanical Systems	**8 Hrs.**

Types of mechanical engineering data (sensor data, vibration signals, thermal images, CAD/CAE data), Data collection and preprocessing (handling missing values, normalization, scaling), Feature selection and extraction, Dimensionality reduction (PCA, LDA), Time-series data handling for mechanical applications.

Unit 3: Supervised & Unsupervised Learning in Mechanical Engineering	**8 Hrs.**

Regression models (Linear, Polynomial, Ridge, Lasso) for mechanical parameter prediction, Classification algorithms (Decision Trees, Random Forest, SVM, k-NN) for fault detection, Clustering techniques (K-Means, DBSCAN, Hierarchical Clustering) for materials classification, Model evaluation metrics (MSE, R^2, Confusion Matrix).

Unit 4: Deep Learning & Neural Networks for Mechanical Systems	**7 Hrs.**

Introduction to Neural Networks (ANN, CNN, RNN), Deep Learning applications in mechanical systems, Image-based analysis for defect detection (CNN), Time-series forecasting for predictive maintenance (LSTM, GRU), Reinforcement Learning for robotics and automation, Case study on AI-driven mechanical system optimization.

Unit 5: Optimization Techniques & AI in Design & Manufacturing	**7 Hrs.**

Genetic Algorithms & Evolutionary Computation for design optimization, Bayesian Optimization, Reinforcement Learning in mechanical process automation, AI-powered CAD/CAE simulations, ML in additive manufacturing (3D Printing), ML in fluid dynamics and aerodynamics analysis, Multi-objective optimization for mechanical designs.

Unit 6: ML-Based Condition Monitoring & Predictive Maintenance	**7 Hrs.**

Vibration-based fault detection using ML, AI-driven predictive maintenance models, ML for real-time sensor data analysis, Case studies on machine health monitoring, Industrial IoT (IIoT) and smart maintenance, ML-based Structural Health Monitoring (SHM) in aerospace and civil structures.

Text Books:

1. Pattern Recognition and Machine Learning by Christopher M. Bishop – A comprehensive guide to statistical pattern recognition and machine learning with a strong mathematical foundation.
2. Machine Learning by Tom M. Mitchell – A classic introductory book covering key ML algorithms with intuitive explanations.
3. An Introduction to Statistical Learning by Gareth James et al. – Beginner-friendly ML book with R-based applications and statistical insights.
4. The Elements of Statistical Learning by Hastie, Tibshirani, Friedman – Advanced text on statistical models and learning theory for experienced readers.

Reference Books:

1. Deep Learning by Ian Goodfellow, Yoshua Bengio, Aaron Courville – Authoritative book on deep learning theory, models, and applications.
2. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow by Aurélien Géron – Practical, Python-based guide to ML and deep learning implementation.
3. Python Machine Learning by Sebastian Raschka – Applied ML book using Python, covering essential algorithms and real-world projects.

SEMESTER - VI

Course Code	Course Title				Category
24ES04TH0601	**Robotic Process Automation**				PCC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	0	2	50	50	3

Course Objectives:

1. To Develop the processes using RPA & cognitive services of Blue Prims, UiPath, Automation Anywhere, for various automation applications.

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

CO1. Understand Robotic Process Automation (RPA) and its value proposition
CO2. Understand various RPS skills.
CO3. Learn different RPA tools and use different component to automate process.
CO4. Learn and use Web, Email, Excel, Database, API etc. and Image Automation.
CO5. Understand RPA services and its integration with RPA Tools.

UNIT I: Robotic Process Automation (RPA) Foundation:	**8Hrs.**
Overview of RPA, Development of RPA, Evolution of RPA, Differentiating RPA from Automation, Assisted and unassisted automation, Defining Robotic Process Automation & its benefits, comparison to other automation technology.	
UNIT II: **RPA Skills:**	

On premise Vs. the cloud, Web Technology, Programming Languages and low code, OCR, APIs, Cognitive automation, flowchart.	
UNIT III: Process Methodologies:	**8Hrs.**
Lean, Six Sigma, Applying lean and Six Sigma to RPA.	
UNIT IV: Planning and BOT Development:	**8Hrs.**
How Robotic Process Automation works, RPA development methodology and key considerations, Robotic Process Automation Tools. Sequence flowchart and control flow, various types of loops and decision making, Introduction to UiPath platform and its components, Types of Templates, User Interface Domains in Activities Workflow, Files in UiPath.	
UNIT V:	**8Hrs.**
Automate login to your (web)Email account Recording mouse and keyboard actions to perform an operation Scraping data from website and writing to CSV/Excel Programming, Debugging and Logging Deployment and Monitoring, Data Preparation, RPA Vendors, Blue Prism, UiPath platform etc. Open Source RPA, Future of RPA.	
TEXT BOOKS: Taulli T. Process Mining. The Robotic Process Automation Handbook 2020:A Guide to Implementing RPA System (pp. 273-292). Apress, Berkeley, CA.	
REFERENCE BOOKS: Tripathi AM. Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool–UiPath. Packt Publishing Ltd; 2018 Mar 28.	

Course Code	**Course Title**				**Category**
24ES04TP0602	**Computer Aided Engineering**				PCC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	2	2	50	50	4

Course Objectives:

1. To solve the complex problem of mechanical engineering (Structural and Thermal) domain by finite element method.
2. To develop the computational proficiency to analyze any structure using any analysis software.

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

CO1. Understand the basic concept of FEM and stress analysis.
CO2. Demonstrate the various approaches to find the field variable.
CO3. Analyze the machine elements using 1-Dimensional elements.
CO4. Analyze plain stress, plain strain and axi-symmetric problems by using CST elements.

CO5. Analyze the beam and structure subjected to free vibration.

UNIT I:	**8Hrs.**
Fundamental concepts of FEM, Historical background, Scope of FEM in Engg. Applications, Fundamentals of stress & strain, stress & strain components, stress-strain relationship, Elastic constants, plane stress, plane strain condition, differential equation of equilibrium, compatibility equations, boundary conditions, Saint Venant's principle, sky line approach.	
UNIT II:	**8Hrs.**
Comparison of FEM with other approaches like Galerkin, Petro-Galerkin, Least square and Sub- domain method. Rayleigh-Ritz method, Principle of minimum potential energy, Basic steps in FEM, Methods for solution of simultaneous equations like Gauss elimination, Concept of discritization of body into elements, types of coordinate system degrees of freedom, bandwidth, Basic types of 1-D, 2- D & 3-D elements, displacement models, convergence requirements.	
UNIT III:	**8Hrs.**
Analysis of one-dimensional and spring element, significance of shape function, Derivation of stiffness matrix, load vector, stress and strain calculation, temperature effects. Analysis of one-dimensional subjected to torsion, Analysis of two-dimensional trusses.	
UNIT IV:	
Two dimensional problems using CST (Constant Strain Triangle), elemental stiffness matrix, global stiffness matrix, stress and strain calculation. Analysis of axi-symmetric solid subjected to axi- symmetric loading using CST element. Introduction to LST.	
UNIT V:	**8Hrs.**
Finite element modeling of Beam element, derivation of stiffness matrix and load vector, boundary conditions. Introduction to dynamic analysis, formulation of mass matrix for one- dimensional bar element, free vibration analysis using one-dimensional bar element.	
UNIT VI:	**8Hrs.**
Steady state one dimensional and two-dimensional heat conduction problems using I-D and triangular elements respectively. Introduction to Iso-parametric & Higher order elements. Preprocessing, solution & Post-processing stages in FEM.	

TEXT BOOKS:

1. Timoshenko S.P., Theory of Elasticity, McGraw Hill.
2. Chandrupatla T. R. & Belegundu A. D., Introduction to Finite Elements in Engineering, PHI.
3. Alavala C.R., Finite Element Methods: Basic Concepts and Applications, PHI.

REFERENCE BOOKS:

1. Finite Element Method- Daryl L. Logan (Cengage Learning)
2. Saeed Moaveni, Finite Element Analysis, Pearson.
3. Bhavikatti S. S., Finite Element Analysis, New Age International.

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

1. Introduction to finite element analysis software.
2. Finite element analysis problem of 1- dimensional bar element subjected to axial loading.
3. Finite element analysis problem of 1- dimensional bar element considering self-weight.
4. Finite element analysis problem of 1- dimensional bar element subjected temperature.
5. Finite element analysis problem of 2-dimensional trusses.
6. Finite element analysis problem of plane stress condition problem using CST element.
7. Finite element analysis problem of axi-symmetric condition problem using CST element.
8. Finite element analysis of shaft/beam using beam element.

Course Code	Course Title				Category
24ES04TH0603	**Applied Thermal Engineering**				
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	2	2	50	50	3

Prerequisite: Basic knowledge of Thermodynamics, Fluid Mechanics, and Heat Transfer

Course Objectives:

1. To develop understanding of energy systems and thermal applications.
2. To analyze and evaluate performance of thermal equipment.
3. To study heat exchangers, refrigeration, air conditioning, and IC engines.
4. To introduce renewable thermal energy sources.
5. To enhance knowledge in energy conversion and system efficiency improvement

Course Outcomes: Upon successful completion of this course, the student will be able to:
CO1: Analyze and evaluate the performance of thermal systems.
CO2: Design and select appropriate heat exchangers.
CO3: Explain principles of refrigeration and air conditioning systems.
CO4: Understand internal combustion engine operations and efficiency.
CO5: Apply concepts of renewable energy systems in thermal applications

UNIT I: Thermal System Design & Power Cycles Introduction to thermal systems, power cycles – Carnot, Rankine, Brayton, and Otto cycles, Analysis of steam and gas power plants, Combined cycle systems, Performance parameters, Case studies of thermal system designs.	**09 Hrs.**
UNIT II: Heat Exchangers Classification of heat exchangers, LMTD and NTU methods, Effectiveness calculation, Design considerations for shell-and-tube and compact heat exchangers, Fouling and maintenance, Thermal performance and selection criteria.	**09 Hrs.**
Unit III: Refrigeration and Air Conditioning Systems Vapor compression and vapor absorption refrigeration systems, COP, refrigerants, Psychometrics – processes, charts, Air conditioning systems – summer and winter air conditioning, Load calculations and system design	**09 Hrs.**
Unit IV: Internal Combustion Engines Classification of engines, working principles, fuel systems, combustion in SI and CI engines, Performance characteristics and testing, Emissions and control techniques, Engine cooling and lubrication systems.	**09 Hrs.**

Unit V: Renewable Thermal Energy & Waste Heat Recovery	**09 Hrs.**
Solar thermal systems – collectors, storage, applications, Biomass combustion and gasification, Geothermal energy basics, Waste heat recovery methods – recuperators, regenerators, heat pipes, Energy conservation opportunities.	

Text Books:

1. R.K. Rajput, "Thermal Engineering", Laxmi Publications, 10th Edition.
2. Yunus A. Cengel& Michael A. Boles, "Thermodynamics: An Engineering Approach", McGraw Hill Education.
3. P.L. Dhar, "Thermal System Design and Simulation", Elsevier

Reference Books:

1. S. Domkundwar& C.P. Kothandaraman, "Thermal Engineering", DhanpatRai& Co.
2. D.S. Kumar, "Heat and Mass Transfer", S.K. Kataria& Sons.
3. Arora&Domkundwar, "A Course in Power Plant Engineering", DhanpatRai.
4. W.F. Stoecker& J.W. Jones, "Refrigeration and Air Conditioning", McGraw Hill.
5. G.D. Rai, "Non-Conventional Energy Sources", Khanna Publishers

Course Code	**Course Title**				**Category**
24ESPSE04TP0605-1	**3-D Printing & Additive Manufacturing**				Open Electives
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	0	2	50	50	3

Course Objectives:

1.To introduce students to the basic principles, evolution, and classification of additive manufacturing technologies.

2. To familiarize students with different additive manufacturing processes, suitable materials, and their industrial and research applications.

Course Outcomes:

CO1. To provide fundamental understanding of additive manufacturing (AM) technologies.
CO2. To expose students to various AM processes, materials, and applications.
CO3. To highlight design considerations, limitations, and future trends in AM.
CO4. To encourage innovation and application of AM in mechanical engineering and beyond.
CO5. To Design for Additive Manufacturing (DfAM) and Recent Trends

UNIT I: Introduction to Additive Manufacturing	**9Hrs.**
Definition and evolution of AM, Comparison with traditional manufacturing methods, Classification of AM processes, Applications in automotive, aerospace, biomedical and defense sectors	
UNIT II: Vat Photopolymerization and Material Extrusion	**9Hrs.**
Stereolithography (SLA) – principle, equipment, applications Fused Deposition Modeling (FDM) – working, materials, advantages and limitations Design and process parameters affecting quality	
UNIT III: Powder Bed Fusion and Directed Energy Deposition	**9Hrs.**

Selective Laser Sintering (SLS), Selective Laser Melting (SLM), Electron Beam Melting (EBM) Laser Engineered Net Shaping (LENS), Directed Energy Deposition (DED) Material properties and post-processing needs.
UNIT IV: Binder Jetting, Sheet Lamination, and Material Jetting **9Hrs.**
Working principles, suitable materials, and applications Hybrid AM systems Challenges in multi-mater Working principles, suitable materials, and applications
UNIT V: Design for Additive Manufacturing (DfAM) and Recent Trends **9Hrs.**
Topology optimization, lattice structures, and generative design, Support structures and build orientation Advances in 4D printing, bioprinting, and large-scale AM Sustainability and industrial case studies
TEXT BOOKS: 1. "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing" – Ian Gibson, David Rosen, Brent Stucker
REFERENCE BOOKS: 1. "Additive Manufacturing: Innovations, Advances, and Applications" – T.S. Srivatsan and T.S. Sudarshan 2. "Fabricated: The New World of 3D Printing" – Hod Lipson and Melba Kurman 3. "Additive Manufacturing Handbook: Product Development for the Defense Industry" – Olaf Diegel 4. Research articles from journals like Rapid Prototyping Journal, Additive Manufacturing Journal, etc.

Course Code	**Course Title**				**Category**
24ESPSE04TP0605-2	**Renewable Energy Systems**				PSE
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	0	0	50	50	3

Prerequisite:
Course Objectives: 1 To prepare the students to understand the need of renewable energy utilization 2 To aware the students about various Renewable Energy Technologies.
Course Outcomes: CO1. To understand the Energy Scenario and Energy Resources Available in India to identify Challenge of climate change and to understand about Energy conservation and energy efficiency. CO2. Understand the basics of solar radiation, solar photovoltaic systems in detail. To study Solar flat plate collectors and related efficiency. CO3. To understand the Applications of solar energy. To study Solar thermal energy conversion system and Solar electrical energy conversion systems. CO4. To understand the basics and system design of renewable energy systems other than solar system. To study and design wind energy conversion systems. CO5. To know the National energy policy, Carbon Trading- Renewable Energy Certification, Energy use and Energy supply, Overview of renewable energy policy.
UNIT I: Global Energy Scenario **8Hrs.**

Energy Scenario-world and India. Energy Resources Availability in India. Energy consumption pattern. Energy conservation potential in various Industries and commercial establishments. Energy intensive industries - an overview. Challenge of climate change - Energy conservation and energy efficiency – needs and advantages.	
UNIT II: Solar Energy systems	**8Hrs.**
Solar Energy: Introduction, Spectral distribution of solar radiation, beam and diffused radiations, measurement of solar radiation, pyranometer, pyrheliometer, sunshine recorder. Solar radiation geometry, radiation on tilted surface, tilt factors. Solar flat plate collectors: Liquid flat plate collector & their analysis, collector efficiency factor and heat removal factor, collector efficiency, Concept of selective surfaces, some novel designs of solar collectors, Solar air heaters and their analysis.	
UNIT III: Applications of solar energy	**9Hrs.**
Water heating, space heating, drying, refrigeration, distillation, cooking, PV systems. Solar thermal energy conversion: Various concentrating and non-concentrating types of solar collectors, constructional details, performance parameters, solar thermal applications, case studies, advantages and drawbacks, tracking systems Solar energy storage. Solar electrical energy conversion: Construction and working of solar cells and PV modules, different PV technologies, Photovoltaic system components and different applications	
UNIT IV: Renewable energy system designs	**9Hrs.**
Introduction, basics and system design for following systems: Wind and Ocean energy, Biogas, fixed dome & floating drum biogas plants. Ocean energy, Geothermal and MHD power generation. Wind Energy: Basic principle of wind energy conversion system, basic components of WECS, classification of WEC systems. Biodiesel: Types of biodiesel, Trans-esterification process, Properties and application. Fuel Cell Technology: Introduction, Principle of working, Types of fuel cells, Fuel cell efficiency. Hydrogen Energy: Properties of Hydrogen with respect to its utilization as a renewable form of energy, sources of hydrogen, production of hydrogen, electrolysis of water	
UNIT V: Energy policies	**9Hrs.**
National energy policy in the last plan periods, Energy use and Energy supply, Overview of renewable energy policy and the Five-Year Plan programmes, Basic concept of Input-Output analysis, Concept of energy multiplier and implication of energy multiplier for analysis of regional and national energy policy- Carbon Trading- Renewable Energy Certification – CDM. The Sustainable Energy Utility (SEU) Model	
UNIT VI: Energy auditing	**9Hrs.**
Energy Conservation Act 2001. Energy auditing - Definition, need, types of energy audit, methodologies, barriers. Role, Duties and responsibilities of energy managers and auditors. Energy audit questionnaire. Energy management (audit) approach: Understanding energy costs, bench marking, energy performance, matching energy use to requirement, optimizing the input energy requirements; Fuel & energy substitution. Energy Audit in thermal utilities I: Steam Power Plants, Furnaces, Compressed Air System and HVAC & Refrigeration system	
TEXT BOOKS: 1. G.D. Rai, „Non-Conventional Energy Sources, Khanna Publishers, New Delhi. 2. G. N. Tiwari and M. K. Ghoshal, Renewable Energy Sources Basic Principles and Applications, 3. Sukhatme, S.P., "Solar energy", Tata Mc Graw Hill, 2nd Ed 2003 4. Duffie, Beckman, "Solar energy", John Wiley & Sons, 1974	

REFERENCE BOOKS:

1. Rai, G.D., "Non-Conventional energy sources", Khanna Publishers, 3rd Ed 1995
2. Garg H. P.,Prakash J., "Solar Energy – Fundamentals & Applications", Tata McGraw Hill, 1997
3. Khandelwal K., Mahdi, S., "Biogas Techno. -A practical Handbook," TMH, 1st Ed, 1988
4. Thombre S.B., "Book on Thermal Engg," Green Brains Publication, 1st Ed, 2003
5. Bureau of Energy Efficiency Study material for Energy Managers and Auditors Examination: Paper I to IV

List of Experiments:

Measurement of Solar Radiation Using Pyranometer
Performance Analysis of Flat Plate Solar Collector
Design and Evaluation of a Solar Drying System
Demonstration of Solar PV System Setup
Case Study: Solar Applications in Agriculture and Industry
Mini Project: Wind Energy Conversion System Design (WECS)
Biogas and Hydrogen Production Methods
Energy Audit – Industrial Systems
Carbon Trading & Renewable Energy Certification (REC)

Course Code	**Course Title**				**Category**
24ESPSE04T P0605-3	**Human Machine Interface (HMI)**				PSE
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	00	00	50	50	03

Course Objectives:

1 To equip students with a comprehensive understanding of Human-Machine Interface principles, technologies, and applications across various industries.
2 To learn HMI design principles, hardware integration, and user experience considerations.

Course Outcomes: Students will be able to

CO1. Understand the fundamentals of Human-Machine Interaction, including ergonomics, user perception, and industrial applications.
CO2. Apply HMI design principles, user experience concepts, and industry standards to create effective interfaces.
CO3. Analyze different HMI technologies, including touch, voice, gesture-based, and AI-driven adaptive interfaces.
CO4. Evaluate industrial HMI applications, including SCADA, PLC-based systems, and IIoT-driven automation.
CO5. Assess the ethical, security, and cognitive challenges in HMI systems and explore future advancements in the field.

UNIT I: Introduction to Human-Machine Interface **9Hrs.**

Definition and importance of HMI, Evolution of HMI technology, Basic concepts of ergonomics and human factors, Types of HMIs (Tactile, Voice, Gesture-based, Brain-Computer Interfaces), Applications in industries (Manufacturing, Automotive, Healthcare, Robotics).

Relevant to Industry: Siemens, ABB, Rockwell Automation, Tesla	
UNIT II: HMI Design Principles & User Experience	**9Hrs.**
Fundamentals of UI/UX for HMI, Cognitive load and user-centered design, Visual and auditory feedback mechanisms, Color theory and display readability, Human perception and reaction time, Industry standards (ISO 9241, ANSI/HFES). Relevant to Industry: Apple, Google, Microsoft, Bosch	
UNIT III: HMI Technologies & Hardware Integration	**9Hrs.**
Touchscreens and capacitive interfaces, Haptic feedback mechanisms, Speech recognition and voice control systems, Eye-tracking and gesture-based interfaces, Brain-Computer Interfaces (BCI), Wearable HMI devices, Sensors and actuators for interactive systems. Relevant to Industry: Meta (AR/VR), Tesla (Autopilot), Honda (ASIMO), Medtronic (Healthcare Devices)	
UNIT IV: Industrial HMI & Automation Systems	**9Hrs.**
SCADA (Supervisory Control and Data Acquisition), PLC-based HMI systems, IIoT (Industrial Internet of Things) and HMI, Cloud-integrated HMI solutions, Safety and cybersecurity in industrial HMIs, HMI case studies in smart factories. Relevant to Industry: Siemens, Schneider Electric, Rockwell Automation, ABB, Honeywell	
UNIT V: AI & Next-Generation HMI Systems	**9Hrs.**
AI-driven voice assistants and chatbots, Natural Language Processing (NLP) for HMIs, Machine Learning in adaptive interfaces, Augmented Reality (AR) & Virtual Reality (VR) for immersive HMIs, Emotion recognition and affective computing, Future trends in HMI technology. Relevant to Industry: Google (Assistant), Microsoft (HoloLens), Tesla (AI-based interfaces), OpenAI (Chatbots)	
UNIT VI: Challenges, Ethics, and Future Directions in HMI	
Human factors and cognitive limitations in HMI, Ethical considerations in AI-driven HMI, Privacy and security challenges in modern interfaces, Accessibility and inclusive design for differently-abled users, Impact of HMI on human behavior and productivity, Future research areas and emerging trends in HMI technology. Relevant to Industry: Research labs, Policy makers, HCI Experts, Accessibility Advocates	

Course Code	**Course Title**				**Category**
24ESPSE04T P0606	**Industrial Internet of Things**				PSE
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	00	00	50	50	03

Course Outcomes:

1. Understand the basic concepts of the Internet of Things (IoT) and its role in industrial automation, including the working of sensors, actuators, and communication protocols used in IIoT systems.
2. Apply knowledge of data acquisition, cloud and edge computing, and cybersecurity to analyze and implement IIoT solutions in real-world industrial applications like smart manufacturing and predictive maintenance.

Course Objectives:

CO1. To introduce the fundamentals of IoT and its applications in industrial automation.
CO2. To understand sensors, actuators, and communication protocols in Industrial IoT (IIoT).
CO3. To learn about data acquisition, cloud computing, and edge computing in IIoT.
CO4. To explore cybersecurity challenges and solutions in IIoT.
CO5. To study real-world case studies of IIoT in smart manufacturing and predictive maintenance.

UNIT I: Introduction to Industrial IoT (IIoT)	**9Hrs.**

- Definition and significance of IIoT
- Differences between IoT and IIoT
- Key components of IIoT: Sensors, Actuators, Gateways, Cloud
- Industrial applications: Smart Manufacturing, Predictive Maintenance, Supply Chain

UNIT II: Sensors and Actuators in IIoT	**9Hrs.**

- Types of industrial sensors (Temperature, Pressure, Vibration, Proximity)
- Actuators: Pneumatic, Hydraulic, Electric
- Signal conditioning and data acquisition

UNIT III: Communication Protocols in IIoT	**9Hrs.**

- Wired (RS-485, Ethernet, Modbus)
- Wireless (Wi-Fi, Bluetooth, Zigbee, LoRa, 5G)
- Industrial protocols: MQTT, OPC-UA, CoAP

UNIT IV: Edge and Cloud Computing in IIoT	**9Hrs.**

- Role of edge computing in real-time processing
- Cloud platforms for IIoT (AWS IoT, Azure IoT, Google Cloud IoT)
- Data analytics and machine learning for predictive maintenance

UNIT V: Cybersecurity in IIoT	**9Hrs.**

- Security threats in industrial networks
- Encryption, authentication, and secure communication
- Best practices for securing IIoT systems

UNIT VI: Case Studies and Applications	**9Hrs.**

- Smart factories and Industry 4.0
- Remote monitoring and predictive maintenance
- Energy management using IIoT

TEXT BOOKS:

1. Industrial IoT for Architects and Engineers – Perry Lea (Packt Publishing)
2. IoT and Industry 4.0: The Industrial Internet of Things (IIoT) – Justin Patton (Apress)
3. Industrial Internet of Things (IIoT): Intelligent Analytics for Predictive Maintenance – R. Anandan, S. Sudevan (Wiley)

REFERENCE BOOKS:

1. Industry 4.0: The Industrial Internet of Things – Alasdair Gilchrist (Apress)
2. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things – David Hanes et al. (Cisco Press)
3. Industrial Automation and Robotics – A.K. Gupta, S.K. Arora (Laxmi Publications)

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering
Session: 2024-25

Course Code	Course Title				Category
24ESPSE04T P0606	**Hydraulics and Pneumatics**				PSE
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	00	00	50	50	03

Course Objectives:
1. To teach the students various types of hydraulic fluids, seals, actuators and control valves used in fluid power systems.
2. To enable the students to read and design various industrial hydraulic circuits. 3.To understand the working of various components used in pneumatic systems.

Course Outcomes:

CO1. Identify the hydraulic fluids, their properties and various seals used in fluid power systems with their applications.
CO2. Understand the construction and working of various types of hydraulic accumulators, intensifiers and valves.
CO3. Understand the various methods of actuation for Direction Control valves and Flow Control valves.
CO4. Design a hydraulic circuit for a given application.
CO5. Understand the various components, working and applications of pneumatic systems.

UNIT I: **9Hrs.**

Fluid Power Systems: Components, advantages, applications in the field of M/c tools, material handling, hydraulic presses, mobile & stationary machines, clamping &indexing devices etc.Transmission of power at static & dynamic states. Types of Hydraulic fluids like petroleum based,synthetic & water based. Properties of fluids, Selection of fluids, additives, effect of temperature &pressure on hydraulic fluids. Seals, sealing materials, selection of seals, Filters strainers, sources of contamination of fluid & its control.

UNIT II: **9Hrs.**

Accumulators & Intensifiers: Types & functions of accumulators, Intensifiers, applications, selection & design procedure. CONTROL OF FLUID POWER: Necessity of pressure control directional control, Flow control valves, Principle of pressure control valves, direct operated, pilot operated, Relief valves pressure reducing valve, sequence valve & methods of actuation of valves.

UNIT III: **9Hrs.**

Flow Control Valves: Principle of operation, pressure compensated, temp. Compensated flow control valves, meter in & meter out flow control circuits, bleed off Circuits. D. C.Valves: Check valves, types of D.C.Valves: Two way two Position, four way three position, four way two position valves, open center, close center Tandem center valves, method of actuation of valves, manually operated solenoid Operated, pilot operated etc.

Actuators: Linear & Rotary actuators, Hydraulic motors, - Types, vane, gear Piston, radial piston.Calculations of piston velocity thrust under static & dynamic applications. Design Consideration for cylinders. Hoses & Pipes: Types, Materials, pressure drop in hoses/pipes. Hydraulic piping connections.

UNIT IV: **9Hrs.**

Design of Hydraulic Circuits: Circuit illustrating use of pressure reducing valves, sequencing valves, counterbalance Valves, unloading valves with the use of electrical controls, accumulators etc. Maintenance, troubleshooting & safety precautions of Hydraulic Circuits. Methods of control of acceleration

UNIT V:	**9Hrs.**

Pneumatics: Introduction to pneumatic power sources, e.g. reciprocating & rotary Compressors, roots- blower etc. Comparison of pneumatics with Hydraulic power Transmission. Air preparation units, filter, regulators & lubricators. Actuators, linear Single & double acting rotary actuators, air motors, pressure regulating valves. Directional control valves two-way, three way & four-way valves, solenoid operated, Push button; & lever control valves. Flow control valves. Check valves methods of Actuation, mechanical, pneumatic & electrical etc. Pneumatic circuits for industrial applications & automation. e.g. Feeding clamping, Indexing, picking & placing etc.

TEXT BOOKS:

1. Sahashtrabudhe N.V., Introduction to Fluid Power, Nirali Prakashan Pune.
2. Pipenger J.J., Industrial Hydraulics, McGraw Hill Co.
3. Mujumdar S.R., Pneumatics circuits.

REFERENCE BOOKS:

1. Pinches, Industrial Fluid Power, Prentice Hall.
2. Manuals on Industrial Hydraulics, Vickers
3. Stewart H.L., Hydraulics & Pneumatics, Industrial Press.
4. Fluid Power Design Handbook, Yeaple.

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

1) Study of hydraulic fluids and seals used in fluid power systems.
2) Study of contamination of hydraulic fluids and its control.
3) Study of symbols used in hydraulic and pneumatic systems.
4) Study of hydraulic pumps, accumulators and intensifiers.
5) Study of control valves used in hydraulic systems.
6) Study and demonstration of hydraulic circuits used in
(a) CNC Lathe (b) CNC Milling Machine (c) Universal Testing Machine
7) Study of air preparatory unit used in pneumatic systems.
8) Study of control valves used in pneumatic systems.
9) Study and demonstration of following pneumatic circuits on pneumatic circuit trainer:
[a] Control of single acting cylinder using 3/2 D.C. valves (Push button type, Hand lever type and Foot pedal type)
[b] Meter in circuit using double acting cylinder
[c] Meter out circuit using double acting cylinder
[d] Automatic sequencing of motion of 2 double acting cylinders using 5/2 pilot operated D.C. valves
[e] Automatic sequencing of motion of 2 double acting cylinders using Solenoid actuated D.C. valves.

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering
Session: 2024-25

Course Code	Course Title				Category
24ESPSE04T P0605-4	**Drone and electric vehicle Technology**				PSE
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	00	00	50	50	03

Course Objectives:
1. Introduce the fundamentals and classifications of drones and electric vehicles (EVs).
2. Explore structural, mechanical, propulsion, and control systems in drones.
3. Provide an understanding of EV powertrain components and battery technology.

Course Outcomes:
CO1. Describe the key concepts, classifications, and applications of drones and EVs.
CO2. Analyze drone structures, propulsion systems, and flight dynamics.
CO3. Explain the working of EV powertrains, batteries, and charging infrastructure.
CO4. Evaluate sensor integration, control algorithms, and communication systems.
CO5. Interpret emerging technologies, regulations, and safety protocols related to UAVs and EVs

UNIT I: Introduction to Drones and Electric Vehicles **9Hrs.**

Classification of UAVs and EVs, Applications: defense, surveillance, agriculture, transport, logistics, Overview of regulations: DGCA norms (for UAVs), ARAI and AIS norms (for EVs),Market trends and case studies (e.g., Tesla, DJI, Indian EV startups)

UNIT II: Drone Technology **9Hrs.**

Drone structure and frame design, Propulsion systems: motors, propellers, ESCs, Aerodynamics and flight control basics, Navigation and GPS integration, Drone assembly and testing overview

UNIT III: Electric Vehicle Architecture **9Hrs.**

Types of EVs: BEV, HEV, PHEV, Vehicle architecture: motor, controller, battery pack, Types of motors: BLDC, PMSM, induction motors, Power electronics: Inverters, converters, and controllers, Regenerative braking

UNIT IV: Battery and Charging Systems **9Hrs.**

Battery types: Li-ion, solid-state, NiMH, LFP, Battery Management System (BMS), Charging systems: Level 1, 2, 3, wireless charging, Battery modeling, thermal management, Range estimation and SoC/SoH calculations.

UNIT V: Sensor, Communication & Control Systems **9Hrs.**

Sensors: IMU, ultrasonic, lidar, IR, cameras,Microcontrollers and flight control boards: Pixhawk, Ardupilot, Raspberry Pi,Telemetry and wireless communication, Safety and failsafe mechanisms, Introduction to autonomy and AI integration in drones/EVs.

TEXT BOOKS:
1. Electric Vehicle Technology Explained – James Larminie, John Lowry
2. Drones: The Professional Drone Pilot's Manual – Brian Halliday
3. Modern Electric Vehicle Technolog" – C.C. Chan and K.T. Chau

REFERENCE BOOKS:
1. **"Unmanned Aircraft Systems: UAVS Design, Development and Deployment"** – Reg Austin

2. **"Fundamentals of Electric Vehicles: Technology and Economics"** – H. P. Garg, Gaurav Srivastava
3. **"Electric and Hybrid Vehicles"** – Iqbal Husain
4. **DGCA Guidelines and ARAI Manuals** (for regulatory framework)
5. **Datasheets and manuals of drone components (e.g., Pixhawk, BLDC motors)**

Course Code	Course Title				Category
24ESPSE04TP0606	**Synthesis of Mechanisms**				PSE
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	00	00	50	50	03

Course Objectives:
1. To provide foundational understanding of kinematic synthesis of mechanisms.
2. To enable students to design linkages for prescribed motion, path, and function generation.
3. To impart analytical and graphical methods for mechanism synthesis.

Course Outcomes:
CO1. Explain the fundamentals of kinematic synthesis and types of synthesis problems.
CO2. Apply graphical and analytical methods to perform position, path, and function generation.
CO3. Design four-bar and slider-crank mechanisms for specific tasks.
CO4. Synthesize cam profiles and analyze their motion characteristics.
CO5**.** Utilize synthesis methods to develop linkages and mechanisms for engineering applications.

UNIT 1: Introduction to Mechanism Synthesis	**9Hrs.**
Definition and classification: Type, number, and dimensional synthesis,Grashof's criterion and mobility Kinematic inversion and relative motion,Graphical conventions and design criteria.	
UNIT 2: Function, Path, and Motion Generation (Graphical Methods)	**9Hrs.**
Precision points and Chebyshev spacing,Graphical synthesis of four-bar linkages: function generation, path generation, motion generation,Coupler curve synthesis,Inversion method for slider-crank mechanisms.	
UNIT 3: Analytical Synthesis of Linkages	**9Hrs.**
Freudenstein's Equation, Analytical synthesis of four-bar and slider-crank mechanisms for motion/function generation, Use of complex numbers and loop-closure equations, Numerical examples and precision point solution methods	
UNIT 4: Cam Mechanism Synthesis	**9Hrs.**
Types of cams and followers, Displacement diagrams: SHM, parabolic, cycloidal, polynomial,Pressure angle and undercutting, Cam profile synthesis using analytical and graphical approaches	
UNIT 5: Advanced and Special Mechanisms	**9Hrs.**
Spatial mechanism synthesis basics, Pantograph, Geneva mechanism, and straight-line mechanisms,Introduction to gear train synthesis, Software tools and simulation overview for mechanism design (e.g., MATLAB, ADAMS)	

TEXT BOOKS:

1. "Kinematics and Dynamics of Machinery" – C.H. Norton
2. "Theory of Machines" – R.S. Khurmi and J.K. Gupta
3. "Mechanism and Machine Theory" – J.S. Rao and R.V. Dukkipati

REFERENCE BOOKS:

1. "Mechanism Design: Analysis and Synthesis Vol. I & II" – A.G. Erdman and G.N. Sandor
2. "Theory of Machines and Mechanisms" – John J. Uicker, Gordon R. Pennock, and Joseph E. Shigley
3. "Kinematics and Linkage Design" – Allen S. Hall Jr.
4. Research articles and NPTEL Lectures on mechanism synthesis

Course Code	Course Title				Category
24ESPSE04TP0606	**Human Factor Engineering**				PSE
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	00	00	50	50	03

Course Objectives:

1. Learn about different ergonomic principles that go into the design of products and process.
2. Discover about different techniques that are used for identifying, preventing and managing work related stress cases.

Course Outcomes:

CO1. Understand an expanded view of ergonomics
CO2. Recognize the concept of anthropometry.
CO3. Get the insight of cognitive Ergonomics. Acknowledge the importance of human physiology at workplace.
CO4. Apply the ergonomics concept in Visual Terminal Displays and Controls. Explore the Biomechanics and NIOSH
CO5. Apply the ergonomics concept in Biomechanics of Work Musculoskeletal System, Bio Mechanical Models, Low Back Problem

UNIT 1:	**9Hrs.**
Introduction to Ergonomics: Scope, applications. Productivity Correlation, Human machine System Principles of Ergonomics, Process and application of Ergonomics, Research Design and Evaluation Methods	
UNIT 2:	**9Hrs.**
Engineering Anthropometry and Work Space Design : Structural and functional dimensions, collection of anthropometric principles in application of anthropometric data. Design of workplace, seat design.	
UNIT 3:	**9Hrs.**
Cognitive Ergonomics : Concept of information, human information processing model, memory, Problem solving and troubleshooting, Meta Cognition and Effort	
UNIT 4:	**9Hrs.**

Work Physiology : Metabolism & heat regulation, Muscle Structure, energy cost of work load, physical work capacity, whole body fatigue, stresses and work load.	
UNIT 5:	**9Hrs.**
Physical Ergonomics Visual Sensory system, Auditory, Tactile and Vestibular systems, Noise, Illumination, Heat, Design of Displays and Controls	
UNIT - VI	
Biomechanics of Work Musculoskeletal System, Bio Mechanical Models, Low Back Problem, NIOSH, Cumulative Trauma Disorder	
TEXT BOOKS: Human factors Engineering & Design - Mark S. Sanders. Ernest J. Me McCormick: McGraw Hill International Edition 30th September 1992 7th Edition	
1. REFERENCE BOOKS: 2. Ergonomics: Man, in his working Environment-Murrell, K.Chapman and Hall London1980 1st Edition 3. Human Factors Design Handbook-Wooden Vs. McGraw Hill New York 2nd Edition 4. R. S. Bridger, "Introduction to Ergonomics", CRC Press.	

SEMESTER - VII

Course Code	Course Title				Category
24ES04TP0702	**Automation in Manufacturing**				PCC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	2	2	50	50	3

Prerequisite:

Course Objectives: The objective of the course is to prepare the students
1. To be familiar with the modern methods and techniques in the automation field
2. To understand CNC and CMM technology through various machines available.

Course Outcomes: At the end of this course students will be able to
CO1. Understand the knowledge of automation in terms of AFL analysis.
CO2. Understand the line balancing algorithms for station formations and logics.
CO3. Familiarity with industrial robotic, thereby study its components, programming.
CO4. To study and analyze the material handling systems and group technology concept.
CO5. Learning of CNC and CMM technology through various machines available.

Unit - I
Automation- Definition, types, reasons for automating, Automation systems and strategies Types of production, Methods of workpart transport, Transfer mechanisms, parts feeding devices, Production line terminology and analysis.

Unit - II
Analysis of flow lines- Analysis of transfer lines without storage, Storage buffer effectiveness, automated flow lines with storage buffers, Line Balancing: methods of line balancing and algorithms

Unit - III
Numerical Control: NC Basic concepts, Machine control unit and NC components, Tape and tape readers, DNC and CNC, Types and classifications of NC systems, coordinate system and tool motion, NC part programming features, manual part programming, applications of NC.

Unit - IV
Industrial Robotics- Introduction, robot anatomy, robot control systems, accuracy and repeatability and other specifications, robot manipulator configurations, SCARA, wrist configurations, types of end effectors, types of sensors. Different types of robot applications, work cell layout, introduction to robot programming.

Unit – V
Automated material handling & storage- Conveyor systems, Automated Guided Vehicle Systems, Types, Vehicle guidance & Routing, Traffic control & safety, System management, Analysis of AGVS systems, Automated Storage & Retrieval System, Analysis of AS/ RS, Carousel storage systems.

Unit - VI
Group Technology, Part families, parts classification & coding, Opitz and Multiclass classification systems, Production flow analysis. Flexible manufacturing systems: Components, FMS layout configuration data files, system reports, FMS planning and benefits. Automated inspection and types, Coordinate measuring machine, Machine vision system.

TEXT BOOKS:

1. Automation, production System & CIMS: M. P. Groover, Prentice Hall of India, New Delhi
2. Industrial Robotics: M. P. Groover, Roger N. Nagel, Mc Grow-Hill, New Delhi
3. CNC Machines: M. Adithan& B. S. Pabla, New Age International Publications New Delhi

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

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

1. To study automated flow line (AFL) & transfer line mechanism.
2. To Study Line Balancing Algorithms.
3. To study robot basic components and different robot configurations.
4. To study the methods of programming and applications of robots.
5. Performance on Coordinate Measuring Machine (CMM)
6. To study automated material handling and storage systems.
7. To study Group Technology.
8. To study NC component and Program of instructions.
9. To perform CNC - Lathe Programming.
10. To perform CNC - Milling Programming.

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering
Session: 2024-25

Course Code	Course Title				Category
24ESPSE04TH0703-6	**Power Plant Engineering (**Program Specific Elective-IV)				PSE
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	00	00	50	50	03

Prerequisite:

Course Objectives:

1. The purpose of this course is to present the fundamental operations in various power plants to the Students.
2. The objective is also to expose the students to get the insights of economics of power generation and various energy storage devices.

Course Outcomes: Upon successful completion of this course, the student will be able to:

CO1. Investigate the fluctuating loads and probe into economic analysis of power plants.
CO2. Understand Hydrology; express the working principles, analytical treatment and governing of Hydro turbines.
CO3. Analyze the steam power cycle & explore the major equipment of a Steam power plant along With coal handling and ash disposals.
CO4. Explore components, working principles of a gas turbine & diesel electric power plant.
CO5. Demonstrate various energy storage/recovery systems and abstract of renewable solar, wind Energy etc.

UNIT I: Economics of Power Generation Indian Energy scenario, Load curves, various terms & definition, effect of fluctuating load. Power plant economics, Tariffs, load division, and cost of electric energy.	**09 Hrs.**
UNIT II: Hydroelectric Power Plants Hydrology: Rainfall, Runoff, Hydro graph, flow duration curve. Plant capacity estimation. Hydroelectric power plant : Site selection, classification of hydroelectric power plant, different Components, prime movers, governing, models & model testing, advantages.	**09 Hrs.**
Unit III: Steam Power Plants Introduction, Power plant layouts, Analysis of Steam Cycles, Coal: Properties, handling & storage, fuel firing methods, ash & dust handling. Steam generators, steam turbine, condenser and cooling towers.	**09 Hrs.**
Unit IV: Gas Turbine Power Diesel Power Plants Introduction, classification, various components, different arrangement, governing, methods to Improve efficiency. Diesel Electric Power Plant: Introduction, Outline, type of engines, different components, performance, plant layout, comparison with other power plant..	**09 Hrs.**
Unit V: : Energy Storage Systems & Renewable Sources of Energy Peak Load plants, waste heat recovery system. Various energy storage - systems viz. pumped hydro, compressed air, flywheel, battery storage etc. Introduction to unconventional power sources: Solar, wind, Tidal, geothermal etc. Introduction to Nuclear Engineering: Nuclear reactions & its initiation, fission, component of nuclear reactors. Nuclear Reactors: Types of reactors, PWR, BWR, CANDU etc. Nuclear Waste Disposal :Effects of nuclear waste on environment, its disposal to soil, water, air, sea etc.	**09 Hrs.**

Text Books:

1.Nag P. K. , Power Plant Engineering, Tata Mc- Graw Hill Publications, Third Edition.
2. Domkundwar S., Power Plant Engineering, Dhanpatrai& sons.
3. Rajput R.K., Power Plant Engineering, Laxmi Publications, Fifth Edition.

Reference Books:

1. Wakil M.M., Power Plant Engineering, Mc-Graw Hill.
2. Black and Veatch, Power Plant Engineering, CBS Publisher and Distributors.

Course Code	Course Title				Category
24ESPSE04T P0606-1	**Product Life Cycle Engineering (Elective VI)**				MDM
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
02	00	00	50	50	02

Prerequisite: Basic knowledge of Electrical Engineering, Digital Electronics, and Control Systems.

Course Objectives:

1. Understand the various strategies of PLM, concept of product design, development, simulation and support system
2. Interpret the technology forecasting, product innovation, product building & configuration and apply in business processes

Course Outcomes: Upon successful completion of this course, the student will be able to:

CO1 Explain the various strategies of PLM and Product Data Management
CO2 Describe decomposition of product design and model simulation.
CO3 Apply the concept of New Product Development and its structuring.
CO4 Analyze the technological forecasting and the tools in the innovation.
CO5 Apply the virtual product development and model analysis

UNIT I: Introduction to PLM and PDM Introduction to PLM, Need for PLM, opportunities and benefits of PLM, different views of PLM, components of PLM, Design Thinking, PLM feasibility study. PLM Strategies, strategy elements, its identification, selection and implementation. Product Data Management, implementation of PDM systems.	**09 Hrs.**
UNIT II: Product Design Engineering design, organization and decomposition in product design, product design process, Management of product data interfaces, GD&T, annotations, manufacturing notes, Integration of CAM with PLM. PLM methodical evolution in product design, concurrent engineering, design for,, X" and design central development model. Strategies for recovery at end of life, recycling, human factors in product design. Modeling and simulation in product.	**09 Hrs.**
Unit III: Product Development New Product Development, structuring new product development, builds decision support system, estimating market opportunities for new product, new product financial control, implementing new product development, market entry decision, launching and tracking new product program. Concept of redesign of product.	**9 Hrs.**
Unit IV:,. **Technology Forecasting** Technological change, methods of technology forecasting, relevance trees, morphological methods, flow diagram and combining forecast of technologies Integration of technological product innovation and product development in business processes within enterprises,	9 Hrs.

methods and tools in the innovation process according to the situation, methods and tools in the innovation process according to the situation.	
Unit V: Product Building and Structures Virtual product development tools for components, machines, and manufacturing plants: 3D CAD systems, digital mock-up, model building, model analysis (FEA), production (process) planning, and product data technology, Product structures: Variant management, product configuration, material master data, product description data, Data models, Life cycles of individual items, status of items. Introduction to augmented reality, Digital twin and IOT	**9 Hrs.**
TEXT BOOKS: 1. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realisation, Springer-Verlag, 2004. ISBN 1852338105 2. Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006.	
REFERENCE BOOKS: 1. Saaksvuori Antti / Immonen Anselmie, product Life Cycle Management Springer, Dreamtech, 3540-24731-4. 2. Product Lifecycle Management, Michael Grieves, Tata McGraw Hill Kari Ulrich and Steven D. Eppinger, 3. Product Design & Development, McGraw Hill International Edns, 1999.	

Course Code	**Course Title**				**Category**
24ESPSE04TH0703-2	**Microfluidics (Program Specific Elective-IV)**				PSE
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	00	00	50	50	03

Prerequisite: Basic knowledge of fluid mechanics and micro fabrication techniques

Course Objectives:
1. To understand the fundamental principles governing fluid behavior at the microscale.
2. To introduce fabrication methods for microfluidic devices.
3. To explore the applications of microfluidics in biology, chemistry, and diagnostics.
4. To develop the ability to design and analyze microfluidic systems.

Course Outcomes: Upon successful completion of this course, the student will be able to:
CO1: Explain fluid dynamics principles applicable at micro and nanoscale.
CO2: Understand and apply micro fabrication techniques for microfluidic devices.
CO3: Design and model microfluidic channels and components.
CO4: Analyze the performance of microfluidic systems.
CO5: Identify the applications of micro fluidics in healthcare, chemical analysis, and drug delivery

UNIT I: Introduction to Microfluidics Overview, applications, physics at microscale, Reynolds number, continuum hypothesis, scaling laws.	**09 Hrs.**
UNIT II: Microscale Fluid Flow Laminar flow, Hagen–Poiseuille equation, electrokinetic phenomena, mixing and diffusion.	**09 Hrs.**

Unit III: Microscale Heat and Mass Transfer Conduction and convection in microchannels, thermal management, chemical transport.	**09 Hrs.**
Unit IV: Microfabrication Techniques Photolithography, soft lithography, etching, polymer microfabrication, bonding..	**09 Hrs.**
Unit V: Applications of Microfluidics Lab-on-chip systems, point-of-care diagnostics, drug delivery, DNA analysis, environmental sensors.	**09 Hrs.**

Text Books:

1. Patrick Tabeling, *Introduction to Microfluidics*, Oxford University Press.
2. Nam-Trung Nguyen, *Micromixer: Fundamentals, Design and Fabrication*, William Andrew Publishing

Reference Books:

1. YoleDéveloppement, Microfluidic Applications in Life Sciences.
2. Albert Folch, Introduction to BioMEMS, CRC Press

Course Code	Course Title				Category
24ESPSE04TH0703-4	**Armament Technology in Defence**				Program Electives
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	01	00	40	60	04

Prerequisite: Basic knowledge of mechanical systems, materials, and dynamics is recommended.

Course Objectives:

1. To provide fundamental knowledge of weapons and armament systems used in defence.
2. To understand the design, working principles, and applications of armaments.
3. To explore the role of propulsion, ballistics, and guidance systems.
4. To examine safety, reliability, and advancements in armament technology.

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

- **CO1:** Understand classification and operating principles of various defence armaments.
- **CO2:** Analyze propulsion and internal/external ballistics of projectiles.
- **CO3:** Explain the working of guidance, control, and launching systems.
- **CO4:** Evaluate the role of materials and safety mechanisms in armament design.
- **CO5:** Explore modern developments and challenges in armament technology.

UNIT I: Introduction to Armament Technology	**09 Hrs.**
History of weapons; Classification: small arms, artillery, tanks, missiles; Basic weapon functions: launching, guiding, hitting, warhead types.	
UNIT II : Ballistics and Propulsion Systems	**09 Hrs**
Internal ballistics – chamber design, pressure curves; External ballistics – projectile motion, trajectory, air resistance; Propulsion: conventional explosives, propellants, rocket motors.	
UNIT III : Weapons Design and Materials	**09 Hrs.**
Barrel design, recoil systems, gun mounts; Armour and protection; Smart materials and composites; Heat and fatigue in gun barrels.	

UNIT IV : Guidance, Control, and Launching Systems	**09 Hrs.**
Guided weapons – inertial, GPS, laser, radar; Launching mechanisms – rails, canisters, tubes; Target acquisition and tracking; Control surfaces and stability.	
UNIT IV : Safety, Maintenance, and Future Technologies	**09 Hrs.**
Arming and safety mechanisms; Fail-safe design; Handling and storage protocols; Trends: AI in weapons, autonomous systems, directed energy weapons.	

TEXT BOOKS:

1. R.M. Bate, *Fundamentals of Astrodynamics*, Dover Publications.
2. Gurney, *Explosive Engineering*, Springer.
3. M.C. Smith, *Weapons and Warfare: Conventional Weapons and Their Employment*, Brassey's.

REFERENCE BOOKS:

1. G.D. Mukherjee, *Introduction to Ballistics and Armament Technology*, DRDO Publications.
2. R.P. Sharma, *Armament Engineering*, Khanna Publishers.
3. Sutton & Biblarz, *Rocket Propulsion Elements*, Wiley.
4. DRDO Monographs on Weapon Systems (available via DRDO website).

Course Code	**Course Title**				**Category**
24ESPSE04TH0703-5	**Introduction to Corporate Law Practice**				Program Electives
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	01	00	40	60	04

Prerequisite: A basic understanding of business or legal terminology is helpful.

Course Objectives:

1. To provide an overview of the fundamental principles of corporate law.
2. To introduce students to company formation, governance, and compliance.
3. To understand the legal structure of corporations and the roles of directors and shareholders.
4. To develop the ability to analyze corporate legal documents and procedures.
5. To acquaint students with recent trends and legal challenges in corporate governance.

Course Outcomes: On successful completion of the module students will be able to:
CO1: Explain the basic concepts of corporate law and its application in business.
CO2: Understand company incorporation procedures and legal compliance.
CO3: Analyze the roles and responsibilities of company stakeholders.
CO4: Draft and interpret legal documents such as MoA, AoA, board resolutions.
CO5: Apply legal reasoning to case studies related to corporate misconduct, mergers, and takeovers.

UNIT I: Overview of Corporate Law	
Introduction, historical development, key statutes – Companies Act 2013, SEBI regulations, corporate personality, types of companies.	9
UNIT II: Incorporation and Capital Structure	9
Formation, Memorandum and Articles of Association, capital structure, types of shares, issue and allotment, regulatory requirements.	
UNIT III: Corporate Governance and Management	9
Directors: appointment, duties, liabilities; board meetings; corporate social responsibility (CSR); stakeholder roles.	
UNIT IV: Regulatory Compliance and Legal Procedures	9

Audits, disclosures, annual filings, penalties for non-compliance, role of Company Secretary, dispute resolution.	
UNIT V: Recent Trends and Case Studies in Corporate Law	9
Corporate frauds (e.g., Satyam), insider trading, mergers & acquisitions, whistleblower protection, NCLT/NCLAT rulings.	

TEXT BOOKS:

1. Avtar Singh, *Company Law*, Eastern Book Company.
2. A. Ramaiya, *Guide to Companies Act*, LexisNexis.
3. Dr. G. K. Kapoor, *Elements of Company Law*, Sultan Chand & Sons.

REFERENCE BOOKS:

1. Taxmann's Company Law Ready Reckoner.
2. Bare Act of Companies Act, 2013.
3. Legal case digests from Corporate Law Reporter and LiveLaw.in.

Course Code	Course Title				Category
24ESPSE04TH0703-6	**Power Plant Engineering**				Program Electives
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	01	00	40	60	04

Prerequisite: Thermodynamics, Fluid Mechanics

Course Objectives:

1 To introduce students to the different types of power plants and their working principles.
2 To understand various components of thermal, hydro, nuclear, and non-conventional power plants.
3 To study plant economics, performance, and environmental impacts.
4 To evaluate power plant operations and safety protocols.

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

CO1: Identify various types of power plants and understand their operation principles.
CO2: Explain the functioning of different power plant components.
CO3: Analyze the economic and environmental issues in power generation.
CO4: Evaluate performance parameters of various power plants.
CO5: Apply knowledge of safety and pollution control in plant operation.

Unit	Title	Hours
I	**Introduction to Power Plants**	9
	Types of power plants – Steam, Hydro, Nuclear, Diesel, Gas, and Renewable; site selection, load curves, load factor, demand factor.	
II	**Steam Power Plant**	9
	Layout, steam generators, turbines, condensers, cooling towers, feedwater treatment, efficiency.	
III	**Hydroelectric and Nuclear Power Plants**	9

	Hydroelectric plants: classification, components, operation. Nuclear plants: nuclear fuels, reactors, shielding, safety systems.	
IV	**Diesel, Gas Turbine and Non-Conventional Plants**	9
	Diesel and gas turbine plants, combined cycle plants, solar, wind, biomass, geothermal, tidal energy systems.	
V	**Plant Economics and Environmental Aspects**	9
	Cost of power generation, depreciation, tariffs, environmental impact, waste disposal, pollution control, recent developments.	

TEXT BOOKS:

1 P.K. Nag, *Power Plant Engineering*, McGraw Hill Education.
2 M.M. El-Wakil, *Power Plant Technology*, McGraw Hill.
3 R.K. Rajput, *Power Plant Engineering*, Laxmi Publications.

REFERENCE BOOKS:

1 G.R. Nagpal, *Power Plant Engineering*, Khanna Publishers.
2 S.C. Arora and S. Domkundwar, *A Course in Power Plant Engineering*, Dhanpat Rai & Sons.
3 C. Elanchezhian, *Power Plant Engineering*, I.K. International.

Course Code	Course Title				Category
24ESPSE04TH0703-10	**Space Technology**				Program Electives
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	01	00	40	60	04

Prerequisite: Physics, Mathematics, Thermodynamics, and basic knowledge of Engineering Mechanics.

Course Objectives:

1 To understand the history, scope, and applications of space technology.
2 To gain insight into launch vehicles, satellites, and orbital mechanics.
3 To explore space propulsion systems and communication technologies.
4 To study remote sensing, satellite navigation, and space environment.
5 To develop awareness of current developments and missions in space science.

Course Outcomes: On successful completion of the module students will be able to:
CO1: Understand the fundamentals and historical context of space technology.
CO2: Explain the basic principles of orbital mechanics and launch vehicle technologies.
CO3: Identify different satellite subsystems and their functions.
CO4: Analyze propulsion systems and satellite communication principles.
CO5: Apply knowledge to recent trends and applications like GPS, remote sensing, and interplanetary missions.

UNIT I: INTRODUCTION TO SPACE TECHNOLOGY	**09 Hrs.**
History and evolution of space exploration Applications: scientific, commercial, military Key agencies: ISRO, NASA, ESA, Roscosmos, CNSA Overview of major space missions and their outcomes	
UNIT II: ORBITAL MECHANICS AND LAUNCH VEHICLES	**09 Hrs.**

Kepler's laws of planetary motion Newton's law of gravitation and equations of motion Satellite orbits and classifications (LEO, MEO, GEO) Launch vehicles: stages, solid and liquid propulsion basics Launch trajectory and payload delivery	
UNIT III: SATELLITES AND SUBSYSTEMS	**9 Hrs.**
Spacecraft configuration and bus systems Power systems: solar panels, batteries Attitude control: sensors and actuators Thermal control and shielding Onboard computing and telemetry	
UNIT IV: SPACE PROPULSION AND COMMUNICATION	**9 Hrs.**
Basics of rocket propulsion Chemical, ion, and electric propulsion systems Communication link: uplink/downlink, antennas Frequency allocation, bandwidth, modulation techniques Deep space communication challenges	
UNIT V: REMOTE SENSING, GPS, AND SPACE ENVIRONMENT	**9 Hrs.**
Principles of remote sensing and sensors Imaging systems and applications (agriculture, weather, geology) Satellite navigation and GPS system Space debris, radiation belts, and shielding Emerging trends: lunar & Mars missions, private players	
TEXT BOOKS: 1 K. Ramadas & R. Satya Prasad, *Introduction to Space Science and Technology*, Universities Press. 2 V. A. Raghunandan, *Fundamentals of Space Systems*, New Age Publishers.	
REFERENCE BOOKS: 1 Larson & Wertz, *Space Mission Analysis and Design*, Microcosm Press. 2 Bate, Mueller, & White, *Fundamentals of Astrodynamics*, Dover Publications. 3 ISRO Official Publications & Annual Reports.	

Course Code	**Course Title**				**Category**
24ESPSE04TP0704-2	**Computational Fluid Dynamics**				Program Electives
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	01	00	40	60	04

Prerequisite: Fluid Mechanics, Heat Transfer, Thermodynamics

Course Objectives:

1 To introduce the basic principles and governing equations of fluid dynamics and heat transfer.
2 To familiarize students with numerical methods used in CFD.
3 To provide knowledge of discretization techniques for solving fluid flow and heat transfer problems.
4 To develop the ability to apply CFD tools for engineering analysis.
5 To prepare students to model and analyze practical thermal and fluid systems using commercial software.

Course Outcomes: On successful completion of the module students will be able to:
CO1: Understand the fundamental principles of CFD and governing equations.
CO2: Apply discretization techniques to fluid flow and heat transfer problems.
CO3: Develop and solve finite difference equations for basic fluid mechanics problems.
CO4: Analyze and interpret numerical results and validate them with theoretical or experimental data.
CO5: Use commercial CFD tools for analyzing real-time engineering problems.

UNIT I: Introduction to CFD	**09 Hrs.**
Need for CFD, applications in various fields, physical laws – conservation of mass, momentum, and energy; classification of partial differential equations, mathematical behavior and implications for solution methods, role of computational methods.	
UNIT II: Governing Equations and Discretization	**09 Hrs.**
General form of governing equations – Navier-Stokes equations; Discretization – Finite Difference Method (FDM), Finite Volume Method (FVM), Finite Element Method (FEM); Introduction to numerical errors, consistency, stability, and convergence.	
UNIT III: Solution of Fluid Flow Equations (09 Hrs)	**9 Hrs.**
Steady and unsteady flows; Explicit and Implicit methods; One-dimensional heat conduction and convection-diffusion equations; Pressure correction techniques – SIMPLE, SIMPLER, and PISO algorithms., and orientation planning.	
UNIT IV: Turbulence Modeling and Heat Transfer	**9 Hrs.**
Need for turbulence models, Reynolds-averaged Navier-Stokes equations (RANS); k-ε and k-ω models; Introduction to Large Eddy Simulation (LES); modeling of heat transfer problems in conduction, convection, and radiation using CFD.	
UNIT V: Applications and CFD Software	**9 Hrs.**
Meshing and grid generation techniques; Pre-processing, solution, and post-processing steps; Use of commercial software (e.g., ANSYS Fluent/OpenFOAM); Industrial applications – HVAC, aerospace, automotive, combustion analysis.	

TEXT BOOKS:

1 Anderson J. D., "Computational Fluid Dynamics – The Basics with Applications", McGraw Hill.
2 Versteeg, H. K., Malalasekera, W., "An Introduction to Computational Fluid Dynamics", Pearson Education.
3 Chung T. J., "Computational Fluid Dynamics", Cambridge University Press.

REFERENCE BOOKS:

1 Patankar S. V., "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing.
2 Blazek J., "Computational Fluid Dynamics: Principles and Applications", Elsevier.
3 Tu J., Yeoh G. H., Liu C., "Computational Fluid Dynamics: A Practical Approach", Elsevier.

Course Code	**Course Title**				**Category**
24ESPSE04TP0704-3	**Supply Chain Management**				Program Electives
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	01	00	40	60	04

Prerequisite: Basic knowledge of Operations Management and Logistics

Course Objectives:

1 To provide an understanding of the key drivers and strategies in supply chain management.
2 To study the design, planning, and operations of supply chains in a competitive environment.
3 To develop analytical and decision-making skills for efficient supply chain execution.
4 To introduce tools for measuring performance and risks in supply chains.
5 To explore the impact of global trends, technology, and sustainability on supply chains.

Course Outcomes: On successful completion of the module students will be able to:
CO1: Understand the concepts, objectives, and components of supply chain management.
CO2: Analyze and apply supply chain strategies to improve performance.
CO3: Evaluate supply chain designs, drivers, and metrics.
CO4: Identify issues in inventory, logistics, sourcing, and risk management.
CO5: Apply digital tools and sustainability practices in supply chains.

UNIT I: Introduction to Supply Chain Management	**09 Hrs.**
Definition and significance of SCM, supply chain structure, decision phases, process view of a supply chain; strategic fit and scope, customer focus and responsiveness.	
UNIT II: Supply Chain Drivers and Metrics	**09 Hrs.**
Key drivers: inventory, transportation, facilities, information, sourcing, and pricing; performance metrics: cost, responsiveness, efficiency; trade-offs among drivers.	
UNIT III: Network Design and Inventory Management	**9 Hrs.**
Designing distribution networks, facility location and capacity allocation; models for strategic network design; inventory models – cycle inventory, safety stock, EOQ, aggregate planning.	
UNIT IV: Sourcing, Logistics, and Coordination	**9 Hrs.**
Supplier selection and contracts; outsourcing and procurement strategies; logistics and transportation models; bullwhip effect and coordination; collaborative planning, forecasting, and replenishment (CPFR).	
UNIT V: Technology, Global Trends, and Sustainability	**9 Hrs.**
Role of IT in SCM – ERP, RFID, IoT, Blockchain; supply chain risks and disruptions; green and sustainable supply chains; global supply chains and future directions.	

TEXT BOOKS:

1 Chopra, S., Meindl, P., & Kalra, D. V., *Supply Chain Management: Strategy, Planning, and Operation*, Pearson.
2 Simchi-Levi, D., Kaminsky, P., & Simchi-Levi, E., *Designing and Managing the Supply Chain*, McGraw-Hill.

REFERENCE BOOKS:

Stadtler, H., Kilger, C., & Meyr, H., *Supply Chain Management and Advanced Planning*, Springer.
Mentzer, J. T., *Fundamentals of Supply Chain Management*, Sage Publications.
Christopher, M., *Logistics and Supply Chain Management*, Pearson Education.

Course Code	**Course Title**				**Category**
24ESPSE04TP0704-4	**Industrial Robotics**				Program Electives
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			

03	01	00	40	60	04

Prerequisite: Basics of mechanical systems, electronics, and control engineering

Course Objectives:

1 To introduce the fundamentals and evolution of industrial robotics.
2 To study robot kinematics, dynamics, and motion control techniques.
3 To understand industrial robot programming and application domains.
4 To explore integration of robots in manufacturing systems.
5 To examine the safety standards, maintenance, and emerging trends in robotics.

Course Outcomes: On successful completion of the module students will be able to:
CO1: Understand the components and classifications of industrial robots.
CO2: Analyze the kinematic structures and workspace of robotic systems.
CO3: Evaluate control strategies and trajectory planning methods for robots.
CO4: Apply robot programming languages for real-time industrial tasks.
CO5: Integrate robots with automation systems and assess their industrial applications.

UNIT I: INTRODUCTION TO ROBOTICS — **09 Hrs.**

Definition of Robot & Robotics, History of Robots, Law of Robotics, Classification of Robots, Present status, and future trends. Subsystems & components of the robotic system. Basic terminology- Accuracy, Repeatability, Resolution, Degree of freedom. Specifications of Robot, Mechanisms and transmission, Links & Joints, End effectors, Grippers-different methods of gripping, Types of grippers, and Selection of Robots.

UNIT II: KINEMATICS AND DYNAMICS OF ROBOTS — **09 Hrs.**

2D, 3D Transformation, Scaling, Rotation, Translation, Homogeneous coordinates, multiple transformations, and Simple problems. Matrix representation, Forward and Reverse Kinematics of Three Degrees of Freedom, Homogeneous Transformations, Inverse kinematics of Robots, Robot Arm dynamics, and D-H representation of robots.

UNIT III: TRAJECTORY PLANNING — **9 Hrs.**

Introduction, Joint space technique, Use of p-degree polynomial, Cubic polynomial, Cartesian space technique, Parametric descriptions, Straight line and circular paths, Position, and orientation planning.

UNIT IV: ROBOT CONTROL, PROGRAMMING AND APPLICATIONS — **9 Hrs.**

Robot Controls- Point-to-point control, Continuous path control, Intelligent robot, Control system for robot joint, Control actions, Feedback devices, Encoder, Resolver, LVDT, Motion Interpolations, Adaptive control. Introduction to Robotic Programming, online and off-line programming, programming examples. Robot Applications- Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting.

UNIT V: DRIVE SYSTEMS, SENSORS, AND ROBOTIC VISION SYSTEM — **9 Hrs.**

Drive system- hydraulic, pneumatic and electric systems; Sensors in robot – Touch sensors, Tactile sensors, Proximity and range sensors, Force sensors, Light sensors, Pressure sensors; Robotic vision system - Low level & High-level vision Sensing & Digitizing, Image processing & analysis, Segmentation, Edge detection, Object description & recognition, Interpretation, Applications, Deep Stream.

TEXT BOOKS:

[1] Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, “Industrial Robotics, Technology programming and Applications", McGraw Hill, 2012.
[2] Craig. J. J. “Introduction to Robotics- mechanics and control”, Addison- Wesley, 1999.
[3] R. K. Mittal and I. J. Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005.

REFERENCE BOOKS:
[1] S.R. Deb, "Robotics Technology and flexible automation", Tata McGraw-Hill Education., 2009.
[2] Richard D. Klafter, Thomas.A, ChriElewski, Michael Negin, "Robotics Engineering an Integrated Approach", PHI Learning., 2009.
[3] Francis N. Nagy, Andras Siegler, "Engineering foundation of Robotics", Prentice Hall Inc., 1987.
[4] P.A. Janaki Raman, "Robotics and Image Processing an Introduction", Tata McGraw Hill Publishing company Ltd., 1995.
[5] Carl D. Crane and Joseph Duffy, "Kinematic Analysis of Robot manipulators", Cambridge University press, 2008.
[6] Fu. K. S., Gonzalez. R. C. & Lee C.S.G., "Robotics control, sensing, vision and intelligence", McGraw Hill Book co, 1987.
[7] Ray Asfahl. C., "Robots and Manufacturing Automation", John Wiley & Sons Inc.,1985.
[8] B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.

Course Code	Course Title				Category
24ESPSE04TP0704-5	**Operations Research & Optimization**				Program Electives
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	01	00	40	60	04

Prerequisite: Basic knowledge of mathematics and linear algebra

Course Objectives:

1 To understand the mathematical modeling of decision-making problems.
2 To introduce optimization techniques for linear, non-linear, and integer problems.
3 To develop problem-solving skills using operations research tools.
4 To equip students with techniques for resource allocation and scheduling.
5 To expose learners to software tools for solving OR models.

Course Outcomes: On successful completion of the module students will be able to:
CO1: Formulate real-world problems as mathematical models using OR techniques.
CO2: Solve linear programming problems using graphical and simplex methods.
CO3: Apply transportation and assignment models for logistics and allocation.
CO4: Analyze sequencing, queuing, and decision problems.
CO5: Use optimization techniques in project management and strategic planning.

UNIT I: Introduction to Operations Research and Linear Programming	**09 Hrs.**
Definition, scope and applications of OR; formulation of LPP; graphical and simplex methods; duality in LPP.	
UNIT II: Transportation and Assignment Problems	**09 Hrs.**
Initial basic feasible solution methods (NWCR, VAM); optimality testing (MODI); balanced and unbalanced problems; Hungarian method for assignments.	
UNIT III: Integer and Nonlinear Programming	**9 Hrs.**
Integer programming models; branch and bound method; cutting plane method; unconstrained and constrained nonlinear optimization techniques; KKT conditions.	
UNIT IV: Queuing Models and Decision Analysis	**9 Hrs.**

Structure and types of queues; M/M/1 and M/M/c models; decision-making under certainty, risk, and uncertainty; decision trees.

UNIT V: Project Management and Dynamic Programming **9 Hrs.**

PERT/CPM networks, critical path analysis, time-cost trade-off; dynamic programming approach to multi-stage decision problems.

TEXT BOOKS:

1 Taha, H. A., *Operations Research: An Introduction*, Pearson Education.
2 Sharma, J. K., *Operations Research: Theory and Applications*, Macmillan India.

REFERENCE BOOKS:

1 Hillier, F. S., & Lieberman, G. J., *Introduction to Operations Research*, McGraw-Hill.
2 Ravindran, A., Phillips, D. T., & Solberg, J. J., *Operations Research: Principles and Practice*, Wiley.
3 Kanti Swarup, Gupta, & Man Mohan, *Operations Research*, Sultan Chand & Sons.

Course Code	Course Title				Category
24ESPSE04TP0704-6	**Unmanned Aerial Systems (UAS)**				Program Electives
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	01	00	40	60	04

Prerequisite: Basic knowledge of control systems and aerodynamics

Course Objectives:

1 To introduce the fundamentals of Unmanned Aerial Systems (UAS).
2 To understand UAS components including payloads, propulsion, and communication systems.
3 To explore regulatory, operational, and ethical considerations for UAS deployment.
4 To study navigation, guidance, and control systems used in UAVs.
5 To expose students to emerging applications of UAS in civil and military domains.

Course Outcomes: On successful completion of the module students will be able to:
CO1: Understand the classification, design, and structure of UAS.
CO2: Identify subsystems including propulsion, control, communication, and payloads.
CO3: Analyze UAS mission planning and autonomous operation techniques.
CO4: Apply control and guidance strategies for UAV stability and path tracking.
CO5: Evaluate applications of UAS across various industries with ethical and regulatory awareness.

UNIT I: Introduction to Unmanned Aerial Systems **09 Hrs.**

Definition, history and evolution; classifications of UAS; fixed-wing, rotary-wing and hybrid UAVs; major components and configurations.

UNIT II: UAS Design and Subsystems **09 Hrs.**

Airframe design; powerplant types; onboard electronics; sensors; communication links; data links and telemetry.

UNIT III: UAS Navigation, Guidance, and Control **9 Hrs.**

Fundamentals of navigation systems; inertial and GPS navigation; autopilot architecture; PID and adaptive control for UAVs.

UNIT IV: Mission Planning and UAS Operations **9 Hrs.**

Flight planning and path optimization; mission control software; remote piloting vs. autonomous operations; integration into airspace; BVLOS.

UNIT V: UAS Applications, Regulations, and Safety **9 Hrs.**

Civil, commercial, and defense applications; drone laws and policies (DGCA/FCC); safety issues, cybersecurity, and future trends.

TEXT BOOKS:

1 Austin, R., *Unmanned Aircraft Systems: UAVS Design, Development and Deployment*, Wiley.
2 Beard, R. W., & McLain, T. W., *Small Unmanned Aircraft: Theory and Practice*, Princeton University Press.

REFERENCE BOOKS:

1 Sadraey, M. H., *Design of Unmanned Aerial Systems*, Wiley.
2 Cook, M. V., *Flight Dynamics Principles*, Elsevier.
3 Mahalik, N. P., *Mechatronics: Principles, Concepts and Applications*, McGraw-Hill.

Course Code	Course Title				Category
24ESPSE04TP0704-7	**Enterprise Resource Planning**				Program Electives
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	01	00	40	60	04

Prerequisite: Basic knowledge of business processes and information systems

Course Objectives:

1 To understand the concepts and architecture of ERP systems.
2 To explore the various functional modules of ERP.
3 To study the implementation lifecycle of ERP in organizations.
4 To analyze challenges, risks, and success factors in ERP implementation.
5 To evaluate ERP software and emerging trends in ERP technology.

Course Outcomes: On successful completion of the module students will be able to:
CO1: Comprehend the structure and features of ERP systems.
CO2: Analyze and map business processes with ERP modules.
CO3: Plan and manage ERP implementation projects.
CO4: Understand integration of ERP with other enterprise systems.
CO5: Evaluate ERP solutions and trends in cloud-based and AI-driven ERP.

UNIT I: Introduction to ERP	**09 Hrs.**

Definition, need and benefits of ERP; Evolution of ERP; ERP architecture; ERP vs traditional information systems; business process reengineering.

UNIT II: ERP Modules and Business Processes	**09 Hrs.**

Overview of modules: finance, manufacturing, HR, sales & distribution, supply chain, CRM; module integration; process mapping and alignment with ERP.

UNIT III: ERP Implementation Lifecycle	**9 Hrs.**

Phases: planning, package selection, gap analysis, reengineering, configuration, training, testing, going live; success/failure factors; change management.

UNIT IV: ERP Tools and Vendors **9 Hrs.**

Overview of major ERP vendors (SAP, Oracle, Microsoft Dynamics); selection criteria; case studies; ERP for SMEs; open-source ERP.

UNIT V: Advanced Topics in ERP **9 Hrs.**

Cloud ERP; mobile ERP; ERP with IoT, AI, ML; ERP integration with business intelligence; security and ethical considerations in ERP.

TEXT BOOKS:

- Alexis Leon, *Enterprise Resource Planning*, McGraw-Hill Education.
- Monk & Wagner, *Concepts in Enterprise Resource Planning*, Cengage Learning.

REFERENCE BOOKS:

1. Jagan Nathan Vaman, *ERP in Practice*, Tata McGraw Hill.
2. Rahul V. Altekar, *Enterprise Resource Planning*, PHI Learning.
3. Ellen Monk, Bret Wagner, *Enterprise Resource Planning*, Course Technology.

Course Code	Course Title				Category
24ESPSE04TP0704-8	**National Accreditation Board for Testing and Calibration Laboratories**				Program Electives
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	01	00	40	60	04

Prerequisite: Basic knowledge of quality control, testing methods, and laboratory operations.

Course Objectives:

1. To provide an understanding of NABL and its role in laboratory accreditation in India.
2. To introduce ISO/IEC 17024 standards for testing and calibration laboratories.
3. To enable students to understand quality management and documentation practices for accreditation.
4. To develop competency in internal auditing and proficiency testing processes.
5. To familiarize students with laboratory information management systems and regulatory frameworks.

Course Outcomes: On successful completion of the module students will be able to:
CO1: Explain the purpose, structure, and functions of NABL.
CO2: Understand and implement ISO/IEC 17024 standards in laboratory environments.
CO3: Prepare quality manuals and SOPs required for laboratory accreditation.
CO4: Conduct internal audits and participate in proficiency testing for compliance.
CO5: Apply quality management systems for continuous improvement in laboratory practices.

UNIT I: Introduction to NABL and Laboratory Accreditation **09 Hrs.**

Overview of NABL; its purpose, structure, and operations; need for accreditation; international recognition; accreditation process and benefits.

UNIT II: ISO/IEC 17024: General Requirements	**09 Hrs.**
Overview of ISO/IEC 17024:2017; scope, normative references, terms and definitions; general, structural, and resource requirements for laboratories.	
UNIT III: Process and Management Requirements	**9 Hrs.**
Requirements for test/calibration methods, equipment, sampling, handling of items, technical records, risk-based thinking, and corrective actions.	
UNIT IV: Quality System Documentation and Auditing	**9 Hrs.**
Quality manual, SOPs, records; internal audits and management reviews; audit planning, execution, and reporting; non-conformance and corrective actions.	
UNIT V: Proficiency Testing and Laboratory Information Systems	**9 Hrs.**
Inter-laboratory comparisons; proficiency testing programs; data integrity; laboratory information management systems (LIMS); ethical and legal aspects.	

TEXT BOOKS:

1 NABL Handbook – *General Information and Accreditation Criteria*.
2 ISO/IEC 17024:2017 – *General Requirements for the Competence of Testing and Calibration Laboratories*.

REFERENCE BOOKS:

1 D. C. Montgomery – *Introduction to Statistical Quality Control*, Wiley.
2 S. P. Gupta – *Statistical Methods*, Sultan Chand & Sons.
3 Quality Council of India (QCI) Publications on Laboratory Accreditation.

Course Code	**Course Title**				**Category**
24ESPSE04TP0704-9	**Non-Destructive Testing**				
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	01	00	40	60	04

Prerequisite: Basic understanding of materials science and manufacturing processes.

Course Objectives:

1 To introduce the principles and techniques of non-destructive testing (NDT).
2 To familiarize students with various NDT methods and their industrial applications.
3 To develop skills to select appropriate NDT techniques for different materials and defects.
4 To understand the interpretation of NDT results for quality control and maintenance.
5 To provide knowledge about the standards, codes, and safety regulations associated with NDT.

Course Outcomes: On successful completion of the module students will be able to:
CO1: Understand the importance of NDT in manufacturing and maintenance.
CO2: Describe various NDT techniques and their working principles.
CO3: Select appropriate testing methods based on defect types and material properties.
CO4: Interpret and analyze NDT results for defect detection and evaluation.
CO5: Apply standards and safety procedures related to NDT in industrial environments.

UNIT I: Introduction to Non-Destructive Testing	**09 Hrs.**

Overview of NDT, need and importance; comparison with destructive testing; classification of NDT methods; defect types; selection of methods.	
UNIT II: Visual Inspection and Liquid Penetrant Testing	**09 Hrs.**
Visual testing tools and techniques; direct and indirect methods; surface defect detection using LPT; penetrant types; developer application; sensitivity and limitations.	
UNIT III: Magnetic Particle Testing and Eddy Current Testing	**9 Hrs.**
Principles of magnetic testing; magnetization methods; particles application and detection; demagnetization; eddy current testing – principles, coil configurations, applications.	
UNIT IV: Ultrasonic Testing and Radiographic Testing	**9 Hrs.**
Ultrasonic wave generation; pulse-echo systems; A-scan, B-scan, C-scan techniques; Radiography – X-ray and Gamma ray sources, detectors, safety; image interpretation.	
UNIT V: Advanced and Emerging NDT Techniques	**9 Hrs.**
Acoustic emission, thermography, digital radiography, phased array, TOFD (Time of Flight Diffraction), industrial applications, safety standards, and NDT certifications.	

TEXT BOOKS:

- ASM Handbook – *Volume 17: Nondestructive Evaluation and Quality Control*, ASM International.
- Charles Hellier – *Handbook of Nondestructive Evaluation*, McGraw-Hill.
- ASNT – *Recommended Practice No. SNT-TC-1A*, The American Society for Nondestructive Testing.

REFERENCE BOOKS:

- Baldev Raj, T. Jayakumar & M. Thavasimuthu – *Practical Non-Destructive Testing*, Narosa Publishing.
- P. E. Mix – *Introduction to Nondestructive Testing*, Wiley.

Course Code	Course Title				Category
24ESPSE04TP0606-1	**Product Lifecycle Engineering**				
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	01	00	40	60	04

Prerequisite: Basic knowledge of product development and engineering design.

Course Objectives:

- To introduce the concept of product lifecycle and its phases.
- To understand engineering practices for managing product lifecycle efficiently.
- To learn tools and techniques for sustainable and cost-effective product development.

- To emphasize the importance of data and knowledge management in product lifecycle.
- To integrate environmental and economic considerations in lifecycle engineering.

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

- **CO1**: Describe the phases and importance of the product lifecycle.
- **CO2**: Apply engineering principles to manage various stages of the lifecycle.
- **CO3**: Use lifecycle tools such as PLM software for data and knowledge management.
- **CO4**: Assess the environmental and economic impact of product decisions.
- **CO5**: Design strategies for sustainable product development and disposal.

UNIT I: INTRODUCTION TO ROBOTICS	**09 Hrs.**

Definition and importance; lifecycle phases: conception, design, manufacture, use, service, disposal; lifecycle thinking; stakeholder perspectives; case examples.

UNIT II: KINEMATICS AND DYNAMICS OF ROBOTS	**09 Hrs.**

Design for X (DFX): manufacturability, reliability, sustainability; concurrent engineering; value engineering; cost analysis across lifecycle stages.

UNIT III: TRAJECTORY PLANNING	**9 Hrs.**

Product Lifecycle Management (PLM) systems; data structuring; configuration management; change management; integration with CAD/CAM/CAE systems.

UNIT IV: ROBOT CONTROL, PROGRAMMING AND APPLICATIONS	**9 Hrs.**

Life Cycle Assessment (LCA); eco-design; materials selection; environmental regulations and compliance; cost–benefit analysis; remanufacturing and recycling.

UNIT V: DRIVE SYSTEMS, SENSORS, AND ROBOTIC VISION SYSTEM	**9 Hrs.**

Applications in automotive, aerospace, consumer products; digital twin and Industry 4.0; IoT in lifecycle management; cloud-based PLM; future of lifecycle engineering.

TEXT BOOKS:

- Saaksvuori, A. & Immonen, A. – *Product Lifecycle Management*, Springer.
- Michael Grieves – *Product Lifecycle Management: Driving the Next Generation of Lean Thinking*, McGraw-Hill.

REFERENCE BOOKS:

- Fabio Giudice, Guido La Rosa, Antonino Risitano – *Product Design for the Environment: A Life Cycle Approach*, CRC Press.
- John Stark – *Product Lifecycle Management (Volume 1): 21st Century Paradigm for Product Realisation*, Springer.
- ISO 14040 – *Environmental Management – Life Cycle Assessment – Principles and Framework*.

Course Code	Course Title	Category

24ESPSE04TP0606-2	**Refrigeration & Air Conditioning**				
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	01	00	40	60	04

Prerequisite: Fundamentals of Thermodynamics and Heat Transfer.

Course Objectives:
- To provide an understanding of the principles of refrigeration and air conditioning systems.
- To introduce various refrigeration cycles and psychrometric processes.
- To analyze components and performance parameters of refrigeration and air conditioning systems.
- To understand the application of refrigeration and air conditioning in real-world systems.

Course Outcomes: On successful completion of the module students will be able to:
- **CO1**: Explain the working principles and types of refrigeration systems.
- **CO2**: Analyze vapor compression and absorption refrigeration cycles.
- **CO3**: Interpret psychrometric charts and perform air conditioning calculations.
- **CO4**: Evaluate the performance of refrigeration and air conditioning components.
- **CO5**: Design simple air conditioning systems for specific applications.

UNIT I: Introduction to Refrigeration — **09 Hrs.**

Basics of refrigeration, units, applications; Carnot refrigeration cycle; methods of refrigeration; refrigerants – types, properties, environmental issues.

UNIT II: Vapor Compression Refrigeration System — **09 Hrs.**

Simple vapor compression cycle – representation on P-H and T-S diagrams; multistage systems; subcooling and superheating; components – compressor, condenser, evaporator, expansion devices.

UNIT III: Absorption and Other Refrigeration Systems — **9 Hrs.**

Vapor absorption system – ammonia-water and Li-Br systems; comparison with VCR system; steam jet refrigeration; thermoelectric and vortex tube refrigeration.

UNIT IV: Psychrometry and Air Conditioning Processes — **9 Hrs.**

Properties of moist air; psychrometric chart; sensible and latent heat processes; cooling and heating load calculations; effective temperature and comfort air conditioning.

UNIT V: Air Conditioning Systems and Applications — **9 Hrs.**

Classification of air conditioning systems; duct design; cooling towers; air distribution systems; applications – industrial, automotive, and residential air conditioning.

TEXT BOOKS:
- Arora, C.P. – *Refrigeration and Air Conditioning*, McGraw-Hill Education.
- Domkundwar, S.C. & Arora, R.S. – *A Course in Refrigeration and Air Conditioning*, Dhanpat Rai & Co.

REFERENCE BOOKS:

- Manohar Prasad – *Refrigeration and Air Conditioning*, New Age International.
- Stoecker, W.F. & Jones, J.W. – *Refrigeration and Air Conditioning*, McGraw-Hill.
- ASHRAE Handbook – *Fundamentals*, American Society of Heating, Refrigerating and Air-Conditioning Engineers.

Course Code	Course Title				Category
24ESPSE04TP0606-3	**Stress Analysis**				
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	01	00	40	60	04

Prerequisite: Mechanics of Solids / Strength of Materials

Course Objectives:

1. To impart knowledge of stress and strain at a point under general loading.
2. To develop the ability to analyze structural elements under static and dynamic loads.
3. To apply analytical techniques for solving two- and three-dimensional stress problems.
4. To understand stress functions and energy methods for complex problems.

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

- **CO1**: Determine stresses and strains in mechanical components under various loading conditions.
- **CO2**: Analyze and interpret principal stresses and Mohr's circle.
- **CO3**: Apply compatibility and equilibrium conditions for 2D stress systems.
- **CO4**: Utilize energy-based methods and stress functions for structural analysis.
- **CO5**: Understand and solve plane stress and plane strain problems.

UNIT I: Stress and Strain Analysis	**09 Hrs.**

Concepts of stress and strain; stress-strain relations; transformation of stress and strain; principal stresses and maximum shear stresses; Mohr's circle for stress and strain.

UNIT II: Analysis of Stress and Strain in 2D	**09 Hrs.**

Plane stress and plane strain problems; compatibility conditions; Airy's stress function; use of stress function in Cartesian coordinates for beams and plates.

UNIT III: 3D Stress and Strain and Torsion	**9 Hrs.**

Stress tensor and strain tensor in three dimensions; equilibrium equations; general torsion theory for prismatic members of non-circular sections.

UNIT IV: Energy Methods	**9 Hrs.**

Strain energy; Castigliano's theorems; virtual work principles; application to deflection and redundancy problems.

UNIT V: Advanced Topics in Stress Analysis	**9 Hrs.**

Thick cylinders; rotating disks; curved beams; contact stresses; introduction to photoelasticity and experimental stress analysis techniques.

TEXT BOOKS:
- Timoshenko, S.P. & Goodier, J.N. – *Theory of Elasticity*, McGraw-Hill.
- S. S. Bhavikatti – *Advanced Mechanics of Solids*, New Age International.

REFERENCE BOOKS:
- Ugural, A.C. & Fenster, S.K. – *Advanced Strength and Applied Elasticity*, Prentice Hall.
- Pytel, A. & Singer, F.L. – *Strength of Materials*, Harper & Row.
- Sadd, M.H. – *Elasticity: Theory, Applications, and Numerics*, Academic Press.

Course Code	Course Title				Category
24ESPSE04T P0606-4	**Field and Service Robots**				
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	01	00	40	60	04

Prerequisite: Fundamentals of Robotics / Basics of Mechatronics

Course Objectives:
- To introduce the design, applications, and control of field and service robots.
- To understand sensors, actuators, and AI techniques used in unstructured environments.
- To develop ability to plan tasks and ensure safety in field and human-interactive operations.
- To impart knowledge of key challenges in deployment of robots outside industrial settings.

Course Outcomes: On successful completion of the module students will be able to:
- **CO1**: Identify the role and types of field and service robots.
- **CO2**: Explain robot design elements suited for outdoor, agricultural, defense, medical, and domestic environments.
- **CO3**: Apply sensor data for navigation, mapping, and localization in unstructured terrains.
- **CO4**: Develop task planning and control strategies for autonomous operation.
- **CO5**: Evaluate real-world case studies of field and service robotic systems.

UNIT I: Introduction to Field and Service Robotics	**09 Hrs.**
Definition, need, and evolution of field and service robots; categories: agriculture, rescue, healthcare, domestic assistance, mining, and space; comparison with industrial robots; design considerations.	
UNIT II: Robot Platforms and Mobility	**09 Hrs.**
Locomotion in uneven terrains, tracked vs. wheeled vs. legged systems; ruggedization and waterproofing; mobility challenges in natural environments.	
UNIT III: Sensors and Perception	**9 Hrs.**
Sensors for field robots: LiDAR, GPS, IMU, stereo and depth cameras; environmental mapping, SLAM techniques; terrain classification and object recognition.	
UNIT IV: Autonomy, AI, and Control	**9 Hrs.**
Control architectures; reactive vs. deliberative strategies; use of AI for decision-making and learning; teleoperation and semi-autonomous systems; safety and human-robot interaction.	
UNIT V: Applications and Case Studies	**9 Hrs.**
Robots in agriculture (weed control, fruit harvesting), military (UGVs), disaster response (search and rescue), medical (rehabilitation and elderly care), household robots; regulations and ethical issues.	

TEXT BOOKS:
- Roland Siegwart, Illah Nourbakhsh – *Introduction to Autonomous Mobile Robots*, MIT Press.
- Robin R. Murphy – *Introduction to AI Robotics*, MIT Press.

REFERENCE BOOKS:
- Springer Handbook of Robotics – Siciliano & Khatib (Springer).
- T. Fukuda – *Field and Service Robotics*, Springer Proceedings.
- M. W. Spong, M. Vidyasagar – *Robot Dynamics and Control*, Wiley.

Course Code	Course Title				Category
24ESPSE04T P0606-5	**Noise, Vibration & Harshness**				
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	01	00	40	60	04

Prerequisite: Basics of Mechanics of Solids / Dynamics of Machinery

Course Objectives:
- To introduce fundamentals of noise and vibration in mechanical systems.
- To analyze causes and effects of noise, vibration, and harshness in automobiles and machines.
- To familiarize with measurement techniques and control strategies.
- To study NVH design principles and testing in automotive and industrial applications.

Course Outcomes: On successful completion of the module students will be able to:
- **CO1**: Understand the sources and characteristics of noise and vibration in mechanical systems.
- **CO2**: Apply analytical techniques to model and predict NVH behavior.
- **CO3**: Utilize instruments and methods for NVH measurement.
- **CO4**: Suggest control measures and design improvements to reduce NVH.
- **CO5**: Interpret case studies related to NVH in automotive and aerospace industries.

UNIT I: INTRODUCTION TO ROBOTICS	**09 Hrs.**
Basics of vibration: free, forced, and damped vibration; introduction to sound waves; terminology – dB, frequency, sound pressure level; physiological and psychological effects of noise.	
UNIT II: KINEMATICS AND DYNAMICS OF ROBOTS	**09 Hrs.**
NVH sources in engines, drivetrains, suspensions, and body structures; structure-borne and air-borne noise; resonance and modal analysis; transmission paths.	
UNIT III: TRAJECTORY PLANNING	**9 Hrs.**
Transducers and sensors: microphones, accelerometers; data acquisition systems; sound level meters; FFT analyzers; signal processing; frequency weighting (A, B, C); standards and regulations.	
UNIT IV: ROBOT CONTROL, PROGRAMMING AND APPLICATIONS	**9 Hrs.**

Passive and active control; vibration isolators and absorbers; damping treatments; acoustic barriers and enclosures; modal modification and balancing.

UNIT V: DRIVE SYSTEMS, SENSORS, AND ROBOTIC VISION SYSTEM — **9 Hrs.**

NVH in passenger cars, electric vehicles, aerospace, HVAC systems, appliances; ride comfort and sound quality; road noise; case studies and simulation tools (LMS, ANSYS, MATLAB, etc.).

TEXT BOOKS:

- Sujatha, C. – *Vibrations and Acoustics: Measurements and Signal Analysis*, McGraw-Hill.
- Rao, S. S. – *Mechanical Vibrations*, Pearson Education.

REFERENCE BOOKS:

- Singiresu S. Rao – *Engineering Noise Control: Theory and Practice*, Wiley.
- Munjal, M. L. – *Noise and Vibration Control*, World Scientific.
- David Bies and Colin Hansen – *Engineering Noise Control*, Taylor & Francis.

Course Code	Course Title				Category
24ESPSE04T P0606-6	**Work System Design**				
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
03	01	00	40	60	04

Prerequisite: Basic knowledge of Industrial Engineering / Engineering Economy

Course Objectives:

- To introduce fundamental concepts of work system design and productivity improvement.
- To study principles and methods of work measurement and workplace layout.
- To understand ergonomic considerations and human factors in system design.
- To apply lean principles to improve work systems and eliminate waste.

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

- **CO1**: Explain the principles of work study and productivity improvement.
- **CO2**: Apply motion and time study techniques for effective work measurement.
- **CO3**: Design efficient workplace layouts considering ergonomics and safety.
- **CO4**: Analyze and improve existing work systems using lean tools.
- **CO5**: Use methods to standardize operations and reduce worker fatigue.

UNIT I: INTRODUCTION TO ROBOTICS — **09 Hrs.**

Definition of work, productivity, and work system; productivity factors; principles of work study; method study – selection, recording, examining, developing, and installing improved methods.

UNIT II: KINEMATICS AND DYNAMICS OF ROBOTS — **09 Hrs.**

Time study – stop watch technique, performance rating, allowances, standard time calculation; work sampling; predetermined motion time systems (PMTS); synthetic and analytical estimation.	
UNIT III: TRAJECTORY PLANNING	**9 Hrs.**
Principles of motion economy; workplace layout and design; ergonomic principles; anthropometry; fatigue and work-rest cycles; safety and human factors in work system design.	
UNIT IV: ROBOT CONTROL, PROGRAMMING AND APPLICATIONS	**9 Hrs.**
Job enlargement, job enrichment, and job rotation; job evaluation and compensation systems; work design in service vs. manufacturing systems; use of simulation and modeling tools.	
UNIT V: DRIVE SYSTEMS, SENSORS, AND ROBOTIC VISION SYSTEM	**9 Hrs.**
Lean manufacturing concepts; elimination of waste (muda); Kaizen, 5S, standard work, visual control; Value Stream Mapping (VSM); real-life applications and case studies.	

TEXT BOOKS:

- ILO – *Introduction to Work Study*, International Labour Office, Geneva.
- Ralph Barnes – *Motion and Time Study*, Wiley.

REFERENCE BOOKS:

- Maynard – *Industrial Engineering Handbook*, McGraw-Hill.
- M. S. Sanders and E. J. McCormick – *Human Factors in Engineering and Design*, McGraw-Hill.
- Niebel, B. W., and Freivalds, A. – *Methods, Standards and Work Design*, McGraw-Hill.

SEMESTER VIII

Course Code	Course Title				Category
24ESPSE04TH0801	**Occupational Health & Safety**				PSE
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	0	2	50	50	3

Prerequisite: Basic knowledge of Environmental Science, Industrial Practices, and Human Anatomy.

Course Objectives:

3. To introduce the principles and practices of occupational health and safety.
4. To understand health hazards, risk assessment, and prevention methods in the workplace.
5. To learn about ergonomics and industrial hygiene.
6. To study national and international safety standards and regulations.
7. To analyze case studies related to occupational health and safety management.

Course Outcomes:
On successful completion of the module students will be able to:
CO1. Understand the fundamental concepts of occupational health and safety.
CO2. Identify workplace hazards and assess associated risks.
CO3. Apply ergonomics and industrial hygiene principles in different work environments.
CO4. Interpret and apply relevant health and safety regulations.
CO5. Develop workplace safety programs and perform audits.

UNIT I: INTRODUCTION TO OCCUPATIONAL HEALTH & SAFETY	**09 Hrs.**
Definition and importance of Occupational Health and Safety (OHS), historical development, principles of accident prevention, types of workplace hazards: physical, chemical, biological, ergonomic, and psychosocial. Key terminology: hazard, risk, exposure, incident, accident. Health and safety culture.	
UNIT II: WORKPLACE HAZARDS AND RISK ASSESSMENT	**09 Hrs.**
Hazard identification techniques, risk assessment matrix, job safety analysis (JSA), hazard control hierarchy, incident investigation and reporting. Personal protective equipment (PPE). Safety signage and labeling.	
UNIT III: INDUSTRIAL HYGIENE AND ERGONOMICS	**09 Hrs.**
Principles of industrial hygiene, monitoring and control of occupational exposure (dust, fumes, noise, etc.). Ergonomic design, work-rest cycles, musculoskeletal disorders. Impact of workplace design on productivity and health.	
UNIT IV: LEGISLATION AND MANAGEMENT SYSTEMS	**09 Hrs.**
Overview of OSHA, Factory Act, National Safety Council guidelines, ILO conventions. ISO 45001:2018 standard. Roles and responsibilities of safety officers. Safety audits and inspections. Emergency preparedness and disaster management.	
UNIT V: CASE STUDIES AND EMERGING TRENDS	**09 Hrs.**
Analysis of real-life industrial accidents and preventive strategies. Health surveillance programs. Role of safety in sustainability and CSR. Mental health and well-being in workplace. Technology in OHS: Wearables, IoT, AI, and data analytics.	

TEXT BOOKS:
1. Goetsch D. L., "Occupational Safety and Health for Technologists, Engineers, and Managers", Pearson Education, 8th Ed., 2015.
2. Hughes, P. and Ferrett, E., "Introduction to Health and Safety at Work", Routledge, 6th Ed., 2016.

REFERENCE BOOKS:
1. Ridley, J., "Safety at Work", Routledge, 7th Ed., 2008.
2. Reese, C.D., "Occupational Health and Safety Management: A Practical Approach", CRC Press, 3rd Ed., 2015.
3. Gupta, R.S., "Handbook of Occupational Safety and Health", CBS Publishers, 2010.

Course Code	**Course Title**				**Category**
24ESPSE04TH0802	**Multi Criteria Decision Making & Analysis**				PSE
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
3	0	2	50	50	3

Prerequisite: Basic understanding of Engineering Mathematics, Probability & Statistics, and introductory knowledge of Operations Research or Optimization Techniques.

Course Objectives:
The purpose of this course is to introduce the concepts, tools, and techniques of decision-making under multiple criteria. It emphasizes both theoretical foundations and practical applications in various domains.

Course Outcomes: On successful completion of the module students will be able to:
CO1. Understand the basic concepts in multi-criteria decision making.
CO2. Apply methods like AHP, ANP, TOPSIS, and VIKOR in decision analysis.
CO3. Analyze group decision-making problems using voting and DEA methods.
CO4. Apply structural modeling techniques such as ISM, MICMAC, and DEMATEL.
CO5. Implement MCDM techniques for solving real-life industrial and societal problems.

UNIT I: Introduction to MCDM	**09 Hrs.**

Basics and principles of Multi-Criteria Decision Making (MCDM), Multi-Attribute Decision Making (MADM), Multi-Attribute Value Theory (MAVT).

UNIT II: Classical MCDM Techniques	**9 Hrs**

Multi-Attribute Utility Theory (MAUT), Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), Distance-Based Techniques – TOPSIS, VIKOR.

UNIT III: Group Decision Making	**9 Hrs**

Voting methods, social choice functions, and group aggregation techniques. Data Envelopment Analysis (DEA): CCR and BCC models.

UNIT IV: Structural Modeling Approaches	**9 Hrs**

Interpretive Structural Modeling (ISM), MICMAC Analysis, Decision Making Trial and Evaluation Laboratory (DEMATEL), Grey Theory.

UNIT V: Applications and Case Studies	**9 Hrs**

Decision analysis, sensitivity analysis. Application of MCDM in material selection, supplier evaluation, project prioritization, transportation, healthcare, safety, etc. Real-life case studies and research applications.

TEXT BOOKS:

1. Tzeng, G.-H. & Huang, J.-J., Multiple Attribute Decision Making: Methods and Applications, Chapman and Hall/CRC, 2011.
2. Saaty, T.L. & Vargas, L.G., Models, Methods, Concepts and Applications of the Analytic Hierarchy Process, Springer, 2nd ed., 2012.

REFERENCE BOOKS:

1. Cohon, J.L., Multiobjective Programming and Planning, Dover Publications, 2004.
2. Tzeng, G.-H. & Huang, J.-J., Fuzzy Multiple Objective Decision Making, Chapman and Hall/CRC, 2013.

Course Code	**Course Title**			**Category**
24ESELC04TH0804	**Research Methodology**			ELC
Contact Hours per Week		**CA**	**FE**	**Credits**
L	**P** **S**			

4	0	2	50	50	4

Prerequisite: Basic knowledge of scientific principles, academic writing, and elementary statistics.

Course Objectives:

- To enable students to understand and apply various research methods and tools for academic and applied research.
- To train students in the collection, analysis, and interpretation of data using qualitative and quantitative techniques.
- To enhance skills in problem formulation, literature review, and research reporting.
- To prepare students for academic writing, publication, and ethical research conduct.

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

CO1. Understand and apply basic concepts of research design and methodology.
CO2 Identify research problems and formulate objectives and hypotheses
CO3. Collect, analyze, and interpret data using appropriate tools and techniques.
CO4. Write and present research proposals, literature reviews, and reports
CO5. Apply research ethics, citation styles, and academic integrity principles in research writing.

UNIT I: INTRODUCTION TO RESEARCH	**09 Hrs.**

Definition, objectives, and significance of research. Types of research: Basic, Applied, Descriptive, Analytical, Quantitative, Qualitative. Research process and characteristics. Criteria of good research.

UNIT II: RESEARCH PROBLEM AND DESIGN	**09 Hrs.**

Defining and formulating a research problem. Research questions and hypotheses Review of literature: sources and strategies. Research design: exploratory, descriptive, experimental Sampling methods and sample size determination

UNIT III: DATA COLLECTION AND ANALYSIS	**09 Hrs.**

Types of data: primary vs secondary.Data collection techniques: surveys, questionnaires, interviews, observations, case studies. Measurement scales, reliability, and validity. Statistical tools for data analysis: mean, median, mode, standard deviation.Introduction to inferential statistics: t-test, chi-square, ANOVA (basic concepts). Software tools: Excel, SPSS, R (overview)

UNIT IV: RESEARCH REPORT AND ACADEMIC WRITING	**09 Hrs.**

Structure of research paper, thesis, and technical reports.Citation styles: APA, MLA, IEEE, Chicago Use of reference management tools (Zotero, Mendeley, EndNote). Plagiarism: detection tools and prevention. Writing abstracts, summaries, and conclusions. Peer-reviewed journals and publication process

UNIT V: RESEARCH ETHICS AND INTELLECTUAL PROPERTY	**09 Hrs.**

Ethics in research: plagiarism, fabrication, falsification. Ethical clearance, informed consent, and confidentiality. Patents and copyrights. Introduction to IPR (Intellectual Property Rights). UGC and institutional research guidelines

TEXT BOOKS:

1. Research Methodology: Methods and Techniques by C. R. Kothari & Gaurav Garg. New Age International Research Methodology: A Step-by-Step Guide for Beginnersby Ranjit Kumar. SAGE Publications

REFERENCE BOOKS:

1. Research Design: Qualitative, Quantitative, and Mixed Methods Approachesby John W. Creswell. Pearson Education.
2. Practical Research: Planning and Designby Paul D. Leedy & Jeanne Ellis Ormrod. Pearson

Course Code	Course Title				Category
24ESELC04PR0805	**Full Semester Industry Internship / TBI Internship**				ELC
Contact Hours per Week			**CA**	**FE**	**Credits**
L	**P**	**S**			
0	24	2	100	100	12

Prerequisite: -

Course Objectives:

The objective of this course is to provide students with extensive exposure to the real-world industrial or research environment by engaging them in full-time internship programs. The aim is to:

- Acclimatize students with the environment and functioning of a manufacturing or service industry.
- Enhance employability by offering firsthand experience of the professional role of a mechanical engineer.

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

CO1. Adapt to the working environment, practices, and safety norms of industry/research.
CO2. Understand the practical applications of theoretical knowledge in real-world settings.
CO3. Address transdisciplinary or interdisciplinary challenges found in industrial scenarios.
CO4. Apply mechanical engineering knowledge and problem-solving skills effectively.
CO5. Develop managerial, supervisory, professional, and ethical competencies.
CO6. Exhibit proficiency in business communication, documentation, and professional presentations.

The internship scheme will be governed by the directions of the Academic Council and the guidelines issued by Dean Academic for the conduction and evaluation of the performance of the students. The students who would opt for the Full Semester Internship will have to carry out the same in a reputed manufacturing or service organization. The broad criteria for choosing the appropriate organizations will be that those organizations which can/ do employ the Mechanical Engineers may be considered as acceptable. The internship may be arranged through college T & P Dept/ or by students themselves. If the students arrange the internship on their own the T & P Department/ Parent Department may verify and get satisfied about the credentials of the organization. The internship will also include the internships offered by the College in research, entrepreneurship etc During this internship the students would get a better practical exposure of the working of the industry and can handle some responsibilities and tasks given by the industry which may not be possible during short duration trainings. The students will be required to maintain a log of their work assignments and submit an Internship report towards the end of the Internship. They would have to also submit an internship completion certificate from the respective organization.

HONOR

Course Code	Course Title	Category

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering
Session: 2024-25

24ES04HT0301	**Geometric Dimensioning and Tolerancing (GD&T)**				Honors
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
3	0	2	50	50	3

Prerequisite:

Course Objectives:
The objective of the course is:
1. Understand GD&T principles and their application in design and manufacturing.
2. Interpret technical drawings and identify tolerancing requirements, apply form, orientation and position tolerances.

Course Outcomes: On successful completion of the module students will be able to:
1. Define and apply GD&T as per ASME Y14.5 standard.
2. Interpret and annotate drawings using correct GD&T symbols.
3. Use GD&T for defining form, orientation, location, and runout tolerances.
4. Explain the role of datums and material condition modifiers

Evaluate manufacturability and inspect ability using GD&T

UNIT I: **09 Hrs.**

Introduction to GD&T: Need, importance and scope of GD&T, Coordinate vs. geometric tolerancing
Drawing Standards and Feature Control Frames: ASME Y14.5 symbols, Feature control frames, datum reference frame

UNIT II: **09 Hrs.**

Form Tolerances Straightness, flatness, circularity, cylindricity
Orientation Tolerances Parallelism, perpendicularity, angularity

UNIT III: **09 Hrs.**

Location Tolerances Position tolerance, concentricity, symmetry
Runout Tolerances Circular and total runout

UNIT IV: **09 Hrs.**

Modifiers & Material Conditions: Maximum Material Condition (MMC), Least Material Condition (LMC), Regardless of Feature Size (RFS)

UNIT V: **09 Hrs.**

Measurement and Inspection CMM, surface plates, functional gauges
GD&T in inspection, reports and manufacturing drawings

TEXT BOOKS:

1. P.S. Gill, *Geometric Dimensioning & Tolerancing,* S.K. Kataria & Sons
2. Krulikowski, A., *Fundamentals of Geometric Dimensioning and Tolerancing*, Cengage Learning.
3. Parkinson, A. C., *Principles of Engineering Drawing*, Longman.

REFERENCE BOOKS:

1. James D. Meadows, *Geometric Dimensioning and Tolerancing: Applications, Analysis & Measurement*, CRC Press.
2. Madsen, D. A., & Madsen, D. P., *Engineering Drawing and Design*, Cengage Learning.

Course Code	Course Title				Category
24ES04HT0401	Advanced Solid Modelling & Assembly				Honors
Contact Hours per Week			CA	ESE	Credits
L	P	S			
3	0	2	50	50	3

Prerequisite:

Course Objectives:

1. To build proficiency in advanced 3D modeling and assembly design using CAD tools, including motion simulation and surface modeling.
2. To apply parametric design principles, integrate FEA tools, and solve real-world mechanical design problems through project-based learning

Course Objectives:

CO1. To master advanced 3D modeling techniques using CAD software (e.g., SolidWorks, CATIA, Autodesk Inventor)
CO2. To understand assembly design, constraints, and motion simulation.
CO3. To apply GD&T (Geometric Dimensioning & Tolerancing) principles in modeling.
CO4. To develop skills in surface modeling, parametric design, and finite element analysis (FEA) integration.
CO5. To prepare for real-world mechanical design challenges through project-based learning.

UNIT I: Advanced 3D Modeling Techniques — **09 Hrs.**

- Parametric vs. Direct Modeling
- Sketching constraints and best practices
- Complex features: Lofts, Sweeps, Ribs, Shells

UNIT II: Surface Modeling — **09 Hrs.**

- Introduction to surface modeling
- Creating complex surfaces (Blends, Patches)
- Conversion between solid and surface models

UNIT III: Assembly Design — **09 Hrs.**

- Bottom-up vs. Top-down assembly approaches
- Mating conditions (Coincident, Concentric, Gear, Cam)
- Exploded views and Bill of Materials (BOM)

UNIT IV: Motion Simulation & Analysis — **09 Hrs.**

- Kinematic and dynamic simulations
- Interference detection and collision analysis
- Force, torque, and friction applications

UNIT V: Integration with FEA & Prototyping	**09 Hrs.**
• Exporting models for Finite Element Analysis (FEA) • 3D printing considerations (Supports, Overhangs) • Case studies in automotive/aerospace components	
TEXT BOOKS: 1. **SolidWorks 2023: Advanced Techniques** – *Paul Tran* (SDC Publications) 2. **CATIA V5: From Beginner to Advanced** – *Stefan Berisha* (CreateSpace) 3. **Engineering Design with SolidWorks** – *David Planchard* (McGraw-Hill)	
REFERENCE BOOKS: 1. **Parametric Modeling with Autodesk Inventor** – *Randy Shih* (SDC Publications) 2. **Geometric Dimensioning and Tolerancing** – *James D. Meadows* (CRC Press) 3. **Advanced CAD Modeling: Explicit, Parametric, Free-Form CAD** – *Nikola Vukašinović* (Springer)	

Course Code	**Course Title**				**Category**
24ES04HT0501	**Additive Manufacturing Techniques**				Honors
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
3	0	2	50	50	3

Prerequisite:
Course Objectives: 1. To understand the basic principles, types, materials, and design aspects of additive manufacturing processes. 2. To explore applications, post-processing methods, quality control, and use of AM techniques in real-world prototyping and production.
Course Objectives: CO1. To understand the fundamental principles and classification of additive manufacturing (AM) processes. CO2. To study materials, design considerations, and applications of AM. CO3. To explore post-processing, quality control, and recent trends in AM. CO4. To enable students to apply AM techniques for prototyping and production.

• UNIT I: **Introduction to Additive Manufacturing (AM)**	**09 Hrs.**
• Definition, history, and evolution of AM. • Comparison with subtractive and formative manufacturing. • Classification of AM processes Vat photopolymerization, material extrusion, powder bed fusion, binder jetting, etc. • Advantages, limitations, and applications of AM. .	
UNIT II: **Additive Manufacturing Processes**	**09 Hrs.**

- Vat Photopolymerization (SLA, DLP) – Process, materials, applications.
- Material Extrusion (FDM/FFF) – Process, equipment, filament materials.
- Powder Bed Fusion (SLS, SLM, EBM) – Mechanisms, lasers/electron beams, materials.
- Binder Jetting and Material Jetting – Working principles and applications.
- Sheet Lamination & Directed Energy Deposition (DED).
-

UNIT III: Materials for Additive Manufacturing	**09 Hrs.**

- Polymers: Thermoplastics (PLA, ABS, Nylon), thermosets.
- Metals: Titanium, Aluminum, Stainless steel, Inconel.
- Ceramics and composites in AM.
- Material behavior, process-material compatibility, mechanical properties.

UNIT IV: **Design for Additive Manufacturing (DfAM)**	**09 Hrs.**

- Principles of DfAM.
- Topology optimization and lattice structures.
- Support structures and build orientation.
- CAD tools and file formats (STL, AMF).
- Design rules and constraints in AM.

• UNIT V: **Post-Processing and Applications**	**09 Hrs.**

- Post-processing techniques: Heat treatment, surface finishing, machining, infiltration.
- Inspection, testing, and quality assurance.
- Applications: Aerospace, biomedical, automotive, architecture, tooling.
- Sustainability and economic aspects of AM.

TEXT BOOKS:

1. **Ian Gibson, David Rosen, Brent Stucker** – *Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing*, Springer.
2. **Andreas Gebhardt** – *Understanding Additive Manufacturing*, Hanser Publishers.
3.

REFERENCE BOOKS:

1. Chua C.K., Leong K.F. – *3D Printing and Additive Manufacturing: Principles and Applications*.
2. ASTM/ISO Standards for AM (e.g., ISO/ASTM 52900, ISO/ASTM 52901).
3. Kalpakjian, S., Schmid, S. – *Manufacturing Engineering and Technology* (relevant chapters).

Course Code	**Course Title**				**Category**
24ES04HT0601	**Design for Manufacturing (DFM)**				Honors
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
3	0	2	50	50	3

Prerequisite:

Course Objectives:

1. To develop an understanding of how product design aligns with various manufacturing processes and materials.
2. To equip students with skills to design cost-effective and high-quality products using DFM (Design for Manufacturing) principles.

Course Outcome:

CO1. To understand the integration of product design with manufacturing processes.
CO2. To impart knowledge of DFM principles for different materials and manufacturing methods.
CO3. To enhance decision-making in selection of processes, materials, and tolerances.
CO4. To enable students to design cost-effective, manufacturable, and high-quality products

UNIT I: Introduction to DFM	**09 Hrs.**

- Importance and scope of Design for Manufacturing.
- Product life cycle and concurrent engineering.
- General principles of DFM and DFA (Design for Assembly).
- Cost estimation and value engineering in product design.
- Case studies of successful DFM applications

UNIT II: Tolerances and Fits	**09 Hrs.**

- Dimensional and geometric tolerances.
- Impact of tolerances on manufacturability and cost.
- Selective assembly and statistical tolerancing.
- Design considerations for interchangeable parts.
- Use of GD&T (Geometric Dimensioning and Tolerancing).

UNIT III: DFM for Machining Processes	**09 Hrs.**

- Design recommendations for turning, milling, drilling, and grinding.
- Influence of design on tool life, surface finish, and machining time.
- Design features to avoid machining problems (undercuts, sharp corners, etc.).
- Material selection and machinability considerations.

UNIT IV: DFM for Casting, Forging, and Welding	**09 Hrs.**

- Design guidelines for cast components: wall thickness, draft angles, risers.
- Design considerations for forgings: grain flow, flash, die parting line.
- Welding design: joint types, distortions, residual stresses, accessibility.
- Defect minimization through better design.

UNIT V: DFM for Sheet Metal and Plastic Parts	**09 Hrs.**

- Design principles for shearing, bending, deep drawing.
- Design for press working tools.
- Design for injection molding, blow molding, and extrusion.
- Minimizing defects like warping, shrinkage, sink marks.
- Assembly considerations for plastic parts (snap fits, welding, adhesives).

TEXT BOOKS:

1. **James G. Bralla** – *Design for Manufacturability Handbook*, McGraw Hill.
2. **Geoffrey Boothroyd, Peter Dewhurst** – *Product Design for Manufacture and Assembly*.

REFERENCE BOOKS:

1. Dieter G.E., Schmidt L.C. – *Engineering Design*, McGraw-Hill.
2. Karl T. Ulrich, Steven D. Eppinger – *Product Design and Development*.
3. Spotts M.F. – *Dimensioning and Tolerancing for Engineering Drawings*.

MINOR

Course Code	Course Title				Category
24ES04MT0301	**Basics of Mechanical Engineering**				Minors
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
3	0	2	50	50	3

Prerequisite:

Course Objectives:

The objective of the course is:

1. To introduce students to fundamental concepts of mechanical engineering.
2. To provide basic knowledge of thermodynamics, IC engines, power plants, and refrigeration.
3. To explain manufacturing processes and engineering materials.
4. To provide exposure to basic mechanical systems like power transmission and mechanisms.
5. To develop an understanding of applications in multidisciplinary engineering.

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

CO1. Understand and apply basic laws of thermodynamics and heat engines.
CO2. Explain working principles of IC engines and power generation systems.
CO3. Identify and understand commonly used engineering materials and their properties
CO4. Comprehend basic manufacturing processes.
CO5. Understand mechanical elements used in machines and power transmission.

UNIT I: Thermodynamics and Heat Engines	**09 Hrs.**

- Basic Concepts: System, Boundary, Properties, State, Process, Cycle
- Zeroth, First and Second Laws of Thermodynamics
- Types of Heat Engines and Efficiencies
- Concept of Entropy (Introductory)
- Working of Carnot and Rankine Cycles

UNIT II: Internal Combustion (IC) Engines and Power Plants	**09 Hrs.**

- IC Engines: Classification, Components, Working of 2-Stroke and 4-Stroke Petrol and Diesel Engines
- Performance Parameters
- Overview of Power Plants: Thermal, Hydro, Nuclear, and Solar
- Introduction to Renewable Energy Sources

UNIT III: Refrigeration and Air Conditioning	**09 Hrs.**

- Basic Concepts of Refrigeration
- Working Principle of Vapour Compression and Vapour Absorption Systems
- Air Conditioning: Summer and Winter AC Systems
- Applications in Domestic and Industrial Sectors

UNIT IV: Engineering Materials and Manufacturing Processes — **09 Hrs.**

- Classification of Materials: Metals, Polymers, Ceramics, Composites
- Properties: Mechanical, Thermal, Electrical
- Manufacturing Processes: Casting, Forging, Welding, Machining, 3D Printing
- Introduction to CNC and Automation in Manufacturing

UNIT V: Mechanical Systems and Power Transmission — **09 Hrs.**

- Mechanisms: Slider Crank, Four-Bar, Cam-Follower (Basic Types)
- Power Transmission: Belts, Chains, Gears, Couplings
- Basic Concepts of Bearings and Clutches
- Introduction to Pumps and Compressors

TEXT BOOKS:

- "Basic Mechanical Engineering" – Pravin Kumar, Pearson
- "Elements of Mechanical Engineering" – R.K. Rajput, Laxmi Publications
- "Basic Mechanical Engineering" – D.S. Kumar, S.K. Kataria & Sons

REFERENCE BOOKS:

- "Fundamentals of Mechanical Engineering" – Saeed Moaveni
- "Basic Mechanical Engineering" – P. K. Nag (McGraw Hill)
- Online Resources: NPTEL Lectures, MOOC platforms (SWAYAM, Coursera)

Course Code	Course Title				Category
24ES04MT0401	Energy Systems and Technologies				Minors
Contact Hours per Week			CA	ESE	Credits
L	P	S			
3	0	2	50	50	3

Prerequisite:

Course Objectives:

1. To introduce students to various conventional and non-conventional energy systems.
2. To study energy conversion technologies and their environmental impacts.
3. To develop an understanding of design, performance, and integration of modern energy systems.
4. To evaluate energy policies, efficiency strategies, and system economics

Course Objectives:

CO1. Understand and classify different energy systems and technologies.
CO2. Analyze the working and efficiency of thermal, electrical, and renewable energy systems.
CO3. Design and assess hybrid and integrated energy systems.
CO4. Evaluate the economic and environmental aspects of energy technologies.
CO5. Apply principles of energy system integration for sustainable development.

UNIT I: Introduction to Energy Systems	**09 Hrs.**
• Global and Indian Energy Scenario • Classification of Energy Sources • Characteristics of Conventional and Non-Conventional Energy • Energy Chain: Source → Conversion → Transmission → Utilization • Energy Conversion Principles and Efficiencies	
UNIT II: Conventional Energy Systems	**09 Hrs.**
• Fossil Fuel-Based Systems: Thermal Power Plants, Combustion Systems, Efficiency Improvement • Nuclear Energy Systems: Reactor Types, Fuel Cycles, Safety Aspects • Hydropower Systems: Types, Site Selection, Components, Environmental Impact • Emissions and Carbon Footprint of Conventional Systems •	
UNIT III: Renewable Energy Technologies	**09 Hrs.**
• Solar Energy Systems: Thermal Collectors, PV Systems, Storage • Wind Energy Systems: Aerodynamics, Turbines, Siting, Hybrid Integration • Biomass and Bioenergy: Biogas, Gasifiers, Biofuels • Geothermal and Ocean Energy Systems: Tidal, Wave, OTEC • Comparison and Suitability of Renewable Systems	
UNIT IV: Integrated and Emerging Energy Systems	**09 Hrs.**
• Hybrid Energy Systems: Solar-Wind-Diesel, Smart Grids, Microgrids • Energy Storage Technologies: Thermal, Electrochemical, Mechanical • Cogeneration and Trigeneration Systems • Fuel Cells and Hydrogen-Based Systems • Smart Energy Networks and Demand Response	
UNIT V: Energy System Management and Policy	**09 Hrs.**
• Energy Efficiency in Systems and Devices • Economic Evaluation: Costing, LCOE, Payback, NPV • Life Cycle Analysis and Environmental Impact Assessment • Government Policies and Incentives (MNRE, BEE, International Energy Agencies) • Case Studies: Integrated Energy Planning for Urban and Rural Areas	
TEXT BOOKS: 1. "Energy Systems Engineering: Evaluation and Implementation" – Francis Vanek & Louis Albright 2. "Non-Conventional Energy Resources" – B.H. Khan	
REFERENCE BOOKS: 1. "Renewable Energy: Power for a Sustainable Future" – Godfrey Boyle	

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering
Session: 2024-25

Course Code	Course Title				Category
24ES04MT0501	Product Design and Digital Manufacturing				Minors
Contact Hours per Week			CA	ESE	Credits
L	P	S			
3	0	2	50	50	3

Prerequisite:

Course Objectives:
1. To introduce the fundamentals of product design, innovation, and development.
2. To expose students to tools and technologies in digital design and manufacturing.
3. To integrate CAD, CAM, CAE, and Industry 4.0 tools for product lifecycle.
4. To understand the role of digital twins, additive manufacturing, and automation in modern manufacturing.

Course Objectives:
- **CO1:** Apply structured methods for concept generation, design thinking, and product development.
- **CO2:** Utilize CAD/CAE tools for product modeling and validation.
- **CO3:** Understand and apply principles of digital manufacturing and Industry 4.0.
- **CO4:** Implement additive and subtractive manufacturing strategies for rapid prototyping.
- **CO5:** Integrate digital technologies for smart and sustainable product development.

UNIT I: Fundamentals of Product Design — **09 Hrs.**

- Product development process and lifecycle
- Design thinking and innovation frameworks
- User-centered design, ergonomics, aesthetics
- Concurrent engineering and DFX principles
- Case studies of successful product designs.

UNIT II: CAD and CAE in Product Design — **09 Hrs.**

- Solid and surface modeling (parametric and direct modeling)
- Assembly modeling and tolerance analysis
- Finite Element Analysis (FEA) for design validation
- Topology optimization and generative design
- Digital mock-ups and design iterations

UNIT III: Digital Manufacturing Fundamentals — **09 Hrs.**

- Definition and components of digital manufacturing
- Cyber-Physical Systems and Smart Factories
- Role of CAD/CAM/CAE/PDM/PLM
- Digital threads and digital twins
- Real-time data monitoring and decision-making

UNIT IV: Additive and Subtractive Manufacturing — **09 Hrs.**

- Additive Manufacturing (AM) processes and integration
- Design for Additive Manufacturing (DfAM)
- CNC-based subtractive manufacturing techniques

- Toolpath generation and simulation
- Hybrid manufacturing approaches

UNIT V: Industry 4.0 and Intelligent Manufacturing	**09 Hrs.**

- IoT in manufacturing: sensors, data acquisition
- Cloud manufacturing and digital supply chains
- Automation, robotics, and smart assembly systems
- Sustainability and green manufacturing
- Case studies: Digital manufacturing in automotive, aerospace, healthcare.

TEXT BOOKS:

1. Ulrich, K.T. & Eppinger, S.D. – Product Design and Development, McGraw-Hill
2. Gibson, I., Rosen, D.W., Stucker, B. – Additive Manufacturing Technologies, Springer
3. Michael McClellan – Collaborative Manufacturing: Using Real-Time Information to Support the Supply Chain, CRC Press

REFERENCE BOOKS:

4. **Chitale & Gupta** – Product Design and Manufacturing
5. **Madhusudan Reddy** – Digital Manufacturing and Automation
6. **Kalpakjian & Schmid** – Manufacturing Engineering and Technology

Course Code	**Course Title**				**Category**
24ES04MT0601	**Automotive Technology**				Minors
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
3	0	2	50	50	3

Prerequisite:

Course Objectives:

1. To introduce the layout, structure, and key components of modern automobiles.
2. To study internal combustion engine systems, transmission, suspension, and vehicle control systems.
3. To explore modern technologies like electric vehicles, hybrid systems, and ADAS.
4. To understand safety, emission, and diagnostic technologies in vehicles.

Course Objectives:

- CO1: Describe the construction and working of automotive powertrains and sub-systems.
- CO2: Analyze the performance of engines, transmission, suspension, and braking systems.
- CO3: Understand vehicle electronics and control systems including sensors, ECUs, and CAN.
- CO4: Evaluate emerging automotive technologies including EVs and hybrid vehicles.
- CO5: Apply diagnostic tools and standards for vehicle safety and emission control.

UNIT I: Vehicle Layout and Powertrain Systems	**09 Hrs.**

• Classification and layout of vehicles (FWD, RWD, AWD) • Chassis and body types • IC engine types, construction and working (SI and CI engines) • Engine components, valve timing, engine balancing • Power transmission system: clutch, gearbox (manual and automatic), differential, propeller shaft	
UNIT II: Suspension, Steering, and Braking Systems	**09 Hrs.**
• Suspension types: rigid axle, independent suspension • Springs: leaf spring, coil spring, torsion bar • Hydraulic shock absorbers, active suspension • Steering systems: rack and pinion, power steering, steering geometry • Braking systems: disc, drum, ABS, EBD, regenerative braking	
UNIT III: Automotive Electronics and Control	**09 Hrs.**
• Sensors: throttle position, MAP, oxygen, speed, temperature • ECUs and their functions (engine, transmission, ABS, airbag) • Communication protocols: CAN, LIN, FlexRay • Vehicle diagnostics: OBD-I and OBD-II standards • Instrument clusters and electronic dashboard systems	
UNIT IV: Advanced Vehicle Technologies	**09 Hrs.**
• Introduction to Hybrid Electric Vehicles (HEV) and Electric Vehicles (EV) • Types of hybrid configurations: series, parallel, power-split • Battery technologies (Li-ion, NiMH), BMS and thermal management • Power electronics in EVs: inverters, converters, controllers • Introduction to Fuel Cell Vehicles (FCV)	
UNIT V: Safety, Emissions and Diagnostics	**09 Hrs.**
• Passive and active safety systems: airbags, crumple zones, ESC • ADAS: cruise control, lane assist, parking assist • Emission norms: BS-VI, Euro VI • Catalytic converters, DPF, SCR technologies • Diagnostic Trouble Codes (DTCs) and scan tools	
TEXT BOOKS: • Kirpal Singh – *Automobile Engineering Vol I & II*, Standard Publishers • William H. Crouse, Donald L. Anglin – *Automotive Mechanics*, McGraw-Hill • Bosch Automotive Handbook, Bosch GmbH	
REFERENCE BOOKS: • R. B. Gupta – *Automobile Engineering* • Jack Erjavec – *Automotive Technology: A Systems Approach* • Iqbal Husain – *Electric and Hybrid Vehicles: Design Fundamentals*	

MDM

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
Teaching and Evaluation Scheme B.Tech. in Mechanical Engineering
Session: 2024-25

Course Code	Course Title				Category
24ES03TH0307	**Defense Technology -Defense Platforms**				MDM
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
3	0	2	50	50	3

Prerequisite: Basics knowledge of Indian Defence Systems

Course Objectives:
1. To introduce students to the structural, functional, and technological aspects of land, naval, and aerial defense platforms.
2. To develop awareness about emerging technologies, indigenous capabilities, and strategic applications in defense systems.

Course Outcomes: On successful completion of the module students will be able to:
CO1: Identify and classify various defense platforms used in land, sea, and air operations.
CO2: Explain the basic design principles behind mobility, protection, and firepower in defense vehicles.
CO3: Demonstrate an understanding of the structure and functions of naval and aerial defense systems.
CO4: Analyze the role of emerging technologies such as AI, robotics, and unmanned systems in modern defense applications.
CO5: Evaluate India's indigenous defense capabilities and compare them with global defense technologies.

UNIT I: Introduction to Defense Systems and Platforms	**06 Hrs.**
This unit introduces students to the overview of national defense and security framework, Classification of defense platforms: Land, Air, Naval, Cyber, and Space, Basic technology: weapon systems, support systems, communication and control, Role of mechanical engineers in defense.	
UNIT II: Land-Based Platforms	**06 Hrs.**
This unit give information on Tracked vehicles: Tanks, ARVs, Light Tanks, Infantry Combat Vehicles (ICVs), Armoured Personnel Carriers (APCs), Artillery systems: Towed, SPG, ATAGS, Design principles: mobility, armour, firepower, Logistics and maintenance systems	
UNIT III: Naval Platforms	**06 Hrs.**
In this unit, design, structure and classification of vessels, Warships: Destroyers, Frigates, Corvettes, Submarines, Propulsion systems: Diesel-electric, nuclear, Weaponry and stealth in naval platforms, Vehicle robotics and underwater drones is included.	
UNIT IV: Aerial Platforms	**06 Hrs.**
This unit covers Fighter aircraft types (Tejas, Sukhoi-30 MKI), UAV/drones: Nishant, Rustom, Heron, Helicopters: LCH, Dhruv, Apache, Aerodynamics, propulsion, stealth and avionics, Future aerial combat systems.	
UNIT V: Emerging Technologies in Defense	**06 Hrs.**
Students will be introduced to Network centric warfare and systems, Artificial Intelligence and decision making, Directed Energy Weapons, Unmanned systems: hypersonics, swarm drones, directed-energy weapons, indigenous technology development	

TEXT BOOKS:

1. Understanding Modern Warfare – David Jordan et al.
2. Introduction to Defense Acquisition Management – Defense Acquisition University
3. Weapons: An International Encyclopedia – Diagram Group
4. Military Vehicle Technology – David McLellan
5. Jane's Armour and Artillery – Jane's Information Group

REFERENCE BOOKS:

1. Jane's All the World's Aircraft – Jane's Information Group, IHS Markit, Annual (e.g., 2022)
2. Armoured Fighting Vehicles of the World by Christopher F. Foss – Jane's Publishing Company, 1977
3. Modern Military Technology by Ray Bonds – Salamander Books, 2002
4. Unmanned Aerial Vehicles: Embedded Control by Kimon P. Valavanis – Springer, 2007
5. Modern Naval Combat by David Miller & Chris Miller – Salamander Books, 1991
6. Strategic Missile Systems by Duncan Lennox – Jane's Information Group, Annual (e.g., 2005) Military Technology: Armoured Vehicles, Naval Vessels, Aircraft and Weapons by Chris Chant – Amber Books, 2013.
7. India's Military Modernization: Challenges and Prospects by Stephen P. Cohen & Sunil Dasgupta – Brookings Institution Press, 2010

Course Code	Course Title				Category
24ES03TH0407	**Defense Technology -Warfare Systems**				MDM
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
3	0	2	50	50	3

Prerequisite: Basics knowledge of Indian Warfare Systems

Course Objectives:

1. To provide insights into historical and modern warfare systems and their technological evolution.
2. To understand the structure, components, and working principles of various warfare systems.
3. To explore mechanical engineering contributions in designing and maintaining warfare technologies

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

CO1: Define and classify different types of warfare and identify their historical evolution.

CO2: Analyze the mechanical engineering aspects of conventional weapon systems including tanks, firearms, and artillery.

CO3: Explain the design and functioning of naval and submarine warfare systems including propulsion and stealth.

CO4: Evaluate air and space warfare capabilities including aircraft design, missile systems, and satellite surveillance.

CO5: Assess modern cyber and electronic warfare technologies and their impact on mechanical system vulnerabilities.

UNIT I: Fundamentals of Warfare Systems	**06 Hrs.**

This unit introduces students to the Definition and evolution of warfare, Classifications: Conventional, Asymmetric, Cyber, Electronic, Nuclear, Mechanics and dynamics of military engagements, Mechanical engineering relevance in warfare design..	
UNIT II: Conventional warfare Systems	**06 Hrs.**
This unit covers Ballistics and projectile dynamics, Firearms, artillery, and their mechanical subsystems, Tanks and armored systems – mobility and firing mechanisms, Personal protective equipment and soldier systems.	
UNIT III: Naval and Submarine Warfare	**06 Hrs.**
In this unit, Structure and propulsion of naval ships and submarines, Torpedoes, anti-ship missiles, and sonar systems, Stealth technologies and undersea warfare strategies, Role of materials and mechanics in naval platforms	
UNIT IV: Air and Space Warfare	**06 Hrs.**
This unit covers Combat aircraft and missile systems – design and aerodynamics, Air defense systems – RADAR, AWACS, SAMs, Space-based warfare capabilities – satellites and surveillance, Anti-satellite weapons and hypersonic threats.	
UNIT V: Cyber and Electronic Warfare	**06 Hrs.**
Electronic warfare systems – jammers, decoys, ECM and ECCM, Cyber-attacks and defenses – mechanical system vulnerabilities, Role of AI, IoT and robotics in future warfare, Hybrid warfare and information warfare trends	
TEXT BOOKS: 1. Introduction to Modern Warfare Systems – DRDO Publication 2. Warfare and Military Technology – Martin van Creveld	
REFERENCE BOOKS: 1. Modern Weapons and Warfare – Chris Bishop, 1999 2. Future Warfare – Col. John Antal, 2023 3. Understanding Cyber Warfare – Christopher Whyte 2023 4. DRDO, HAL, and Ministry of Defence technical papers and publications	

Course Code	**Course Title**				**Category**
24ES03TH0507	**Defense Technology -Weapon Systems**				MDM
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			

3	0	2	50	50	3

Prerequisite: Basics knowledge of weapon Systems

Course Objectives:
1. To understand the fundamental principles, classifications, and operation of modern weapon systems.
2. To explore the mechanical engineering aspects involved in the design, dynamics, and deployment of various weapon systems.
3. To study the integration of fire control, propulsion, guidance, and stabilization technologies in weapon design.

Course Outcomes: On successful completion of the module students will be able to:
CO1: Classify and describe the various types of weapon systems used in defense applications.
CO2: Explain the working principles of internal ballistics, external ballistics, and terminal effects.
CO3: Analyze the structural and mechanical components of firearms, cannons, and missile systems.
CO4: Understand the integration of guidance, propulsion, and control in modern smart weapons.
CO5: Evaluate the technological challenges and recent advancements in indigenous weapon development.

UNIT I: Introduction to Weapon Systems	**06 Hrs.**

Definition and classification of weapon systems, Evolution of weapon systems from ancient to modern era, Components: launcher, projectile, guidance, fire control, Role of mechanical engineering in weapon design.

UNIT II: Ballistics and Firing Mechanism	**06 Hrs.**

Internal ballistics – combustion, chamber pressure, recoil, External ballistics – trajectory, drag, wind effects, Terminal ballistics – impact mechanics, penetration, Firing mechanisms in rifles, machine guns, artillery

UNIT III: Missile and Rocket Systems	**06 Hrs.**

Basic structure and classification of missiles and rockets, Propulsion systems – solid, liquid, hybrid, Aerodynamics and heat shielding, Guidance and control mechanisms

UNIT IV: Fire Control and Launch Systems	**06 Hrs.**

Fire control systems – analog/digital, RADAR integration, Launch platforms – mobile, static, naval and aerial-based, Stabilization and recoil mechanisms in launchers

UNIT V: Advanced and Smart Weapons	**06 Hrs.**

Precision-guided munitions (PGMs), loitering munitions, Drone-based delivery systems, Electromagnetic railguns and laser-based weapons, Indigenous technologies – BrahMos, Pinaka, NAG, AKASH, Future trends: hypersonics, AI-guided weapons

TEXT BOOKS:
1. Principles of Guided Missile Design – Dr. M. N. Sinha
2. Weapon Systems and Ballistics – R.K. Arora

REFERENCE BOOKS:
1. Modern Weapons and Warfare – Chris Bishop
2. Fundamentals of Naval Weapons Systems – CDR Craig M. Payne (US Navy)
3. Missile Guidance and Control Systems – George M. Siouris
4. Indian Defence Technology Series – DRDO Publications

5. Military Ballistics: A Basic Manual – Malcolm J. D. Powell

Course Code	Course Title				Category
24ES03TH0607	**Defense Technology -Self-defense & Protection systems**				MDM
Contact Hours per Week			**CA**	**ESE**	**Credits**
L	**P**	**S**			
3	0	2	50	50	3

Prerequisite: Basics knowledge of self defence systems

Course Objectives:
1. To introduce students to the fundamentals and technologies behind personal, vehicular, and infrastructure protection systems.
2. To study the application of mechanical and material engineering in designing armor, shelters, and anti-threat mechanisms.
3. To develop an understanding of modern self-defense technologies and threat mitigation strategies in civil and military domains.

Course Outcomes: On successful completion of the module students will be able to:
CO1: Classify and explain different types of self-defense and protection systems used by individuals and defense forces.
CO2: Understand the design and materials used in bulletproof vests, helmets, and riot gear.
CO3: Analyze vehicle protection technologies including mine-resistant and ambush-protected (MRAP) designs.
CO4: Evaluate technologies used in anti-intrusion, perimeter security, and blast mitigation.
CO5: Assess new-age protection technologies such as exoskeletons, active armor, and AI-based threat response

UNIT I: Introduction to Self-Defense & Protection Systems	**06 Hrs.**
Threat landscape: Civilian and military, Classification: Personal, vehicle, infrastructure protection, Principles of threat assessment and risk analysis, Historical evolution of armor and protective technologies	
UNIT II: Personal Protective Equipment (PPE)	**06 Hrs.**
Ballistic vests, helmets, shields – materials and manufacturing, Stab and blast resistant clothing, Riot gear and tactical suits, Standards: NIJ, STANAG, IS codes	
UNIT III: Vehicle Protection Systems	**06 Hrs.**
Armoring of military and VIP vehicles, Design of MRAPs, blast seats, and underbody protection, Transparent armor: bulletproof glass and visors, Add-on and reactive armor systems.	
UNIT IV: Infrastructure and Perimeter Protection	**06 Hrs.**
Blast-proof bunkers and shelters – structural design, Perimeter security: fences, intrusion sensors, drones, Access control, surveillance systems, and automated countermeasures	
UNIT V: Advanced & Smart Protection Technologies	**06 Hrs.**

Exoskeletons and wearable robotics, Active protection systems (APS): Trophy, Iron Fist, Drone detection and counter-UAV systems, AI-based threat detection and emergency response systems
TEXT BOOKS: 1. Personal Protective Equipment: Design, Material and Technologies – Joseph R. Davis 2. Armor and Protection Systems – R.K. Arora
REFERENCE BOOKS: 1. Modern Ballistic Armor – L. J. Arnold 2. Protective Relaying and Infrastructure Defense – J. Lewis Blackburn 3. Blast Protection of Civil Infrastructures and Vehicles – A. G. Malvar 4. DRDO Publications and DRTC Lecture Notes on Protective Systems 5. IS/NIJ/STANAG specifications and defense procurement guidelines

Ramdeobaba University, Nagpur
Department of Mechanical Engineering
UG Project Guidelines

This Project Manual is designed to serve as a comprehensive guide for students pursuing the B. Tech. program in Mechanical Engineering. The primary aim of this manual is to familiarize students with the structured project curriculum that spans across Semesters IV to VIII, gradually developing their technical, analytical, creative, and research skills.

UG Project Scheme – Mechanical Engineering

Sem	Project Title	Credits	Marks (Int + Ext)	Evaluation Type	No. of Seminars	Internal Mark Distribution
IV	Project I (Mini Project)	1	50	Internal Only	3	- Seminar 1: 10 marks - Seminar 2: 15 marks - Seminar 3 (Demo & Report): 24 marks
VI	Project II	2	100	Internal Only	3	- Seminar 1: 15 marks - Seminar 2: 20 marks - Seminar 3: 24 marks - Report: 40 marks
VII	Project III	4	100 + 100 = 200	Internal + External	3	**Internal (150):** - Seminar 1: 24 marks - Seminar 2: 30 marks -

						Seminar 3: 40 marks - Report & Logbook: 30 marks - Team Coordination: 24 marks
VIII	Project IV	6	100 + 100 = 200	Internal + External	3	**Internal (100):** - Seminar 1: 15 marks - Seminar 2: 20 marks - Seminar 3: 30 marks - Final Report & Poster: 35 marks

Semester IV – Project I (Mini Project)

Component	**Details**
Project Title	**Project I (Mini Project)**
Credits	**1 Credit**
Marks	**50 (Internal Only, No ESE)**
Team Size	**Max 3 Students**

Course Objectives

1. Introduce students to the basics of engineering problem-solving and product development.
2. Foster creativity, curiosity, and innovation using simple engineering principles.
3. Enable hands-on experience with low-risk, low-cost implementations.
4. Develop teamwork, technical documentation, and presentation skills.

Course Outcomes (COs)

CO1: Identify and define a small-scale mechanical engineering problem.
CO2: Design a simple solution using modeling or prototyping.
CO3: Demonstrate technical communication through seminar presentations.

Seminar	**Title**	**Objective**
Seminar 1	Topic Selection & Planning	Identify the problem, define scope and expected outcomes.
Seminar 2	Implementation & Review	Demonstrate progress with methodology or partial model.
Seminar 3	Completion & Reflection	Present the final outcome with reflection on learning and future scope.

Syllabus

1. Idea Generation and Selection – Brainstorming, identifying real-world micro-problems.
2. Design Phase – 2D/3D CAD modeling or concept sketches.
3. Material Selection & Basic Fabrication – Use of locally available/low-cost materials.
4. Testing/Validation – Performance check under basic parameters.
5. Presentation & Reporting – Technical writing and oral communication.

Semester VI – Project II

Title	**Project II**
Credits	2 Credits
Marks	100 (Internal Assessment Only)

Team Size	3–4 Students
Evaluation Method	Departmental Continuous Assessment
Deliverable	Conceptual Report, Timeline Plan, Progress PPT

Course Objectives

1. Encourage exploration of research problems or industry challenges.
2. Equip students with tools for effective literature review and benchmarking.
3. Enable students to plan technically and logistically sound projects for execution in future phases.

Course Outcomes (COs)

CO1: Analyze and define an engineering problem with practical relevance.
CO2: Propose multiple viable solutions and select the best feasible one.
CO3: Develop a structured project plan with resource, time, and risk considerations.

Seminar	Title	Objectives
Seminar 1	Problem Statement & Objectives	Present identified problem, justification, and initial literature survey.
Seminar 2	Conceptual Designs & Plan	Present alternative solutions, resource and time planning, team role allocation.
Seminar 3	Feasibility & Review	Evaluate selected design, feasibility study, finalize tools/software to be used.

Syllabus

Problem Identification – Field survey, research gap analysis.
Literature Review – National/international standards, research papers, benchmarking.
Concept Development – Preliminary concepts, sketching, flowcharts.
Planning Tools – Gantt charts, risk analysis, budget estimation.
Proposal & Ethics – Project proposal writing, environmental/safety/ethical considerations.

Semester VII – Project III

Title	**Project III**
Credits	4 Credits
Marks	100 (Internal) + 100 (External) = 200
Team Size	3–4 Students
Evaluation Method	Mid Reviews + External Viva
Deliverable	Model/Trained System + Performance Report

Course Objectives

1. Guide the full-scale development of engineering prototypes or simulations.
2. Integrate interdisciplinary knowledge for solving complex problems.
3. Facilitate detailed validation, testing, and result analysis.

Course Outcomes (COs)

CO1: Design, model, and build functional engineering systems or sub-systems.
CO2: Analyze real-world data and compare with simulated/theoretical predictions.
CO3: Deliver project outcomes through professional documentation and demonstration.

Seminar	Title	Objectives
Seminar 1	Detailed Design & BOM Review	Present CAD models, part drawings, simulation results, bill of materials.
Seminar 2	Midway Progress & Testing Setup	Demonstrate partial assembly/simulation, discuss testing protocols and safety.

Seminar 3	Pre-ESE Evaluation & Analysis	Present complete system, functional results, challenges encountered, learning outcomes.

Syllabus
Detailed Design – Engineering drawings, CAD, FEA/CFD simulations.
Procurement & Fabrication – Material and tools sourcing, safety procedures.
Model Development – Mechanical assembly, coding (if required), testing strategy.
Data Collection & Analysis – Experimental/simulated data, interpretation.
Documentation – Engineering logbook, test reports, final internal report.

Semester VIII – Project IV

Title	**Project – IV**
Credits	6 Credits
Marks	100 (Internal) + 100 (External ESE) = 200
Team Size	3–4 Students
Evaluation Method	Continuous Review + Final External Panel Viva
Deliverable	Final Project Report, Patent/Journal/PPT Poster

Course Objectives
1. Conclude the project with optimized, validated, and industry/publish-ready outcomes.
2. Promote innovation for potential entrepreneurship or IP filing.
3. Equip students with skills to defend their work at technical platforms.

Course Outcomes (COs)
CO1: Optimize the engineered solution using feedback from prior phases.
CO2: Generate meaningful research outcomes and prepare for publication or patenting.
CO3: Defend project comprehensively before a technical panel and public forum.

Seminar	Title	Objectives
Seminar 1	Architecture & Pipeline Review	Present training/ROS architecture, code libraries, model structure.
Seminar 2	Model Development & Partial Testing	Submit ML training logs, simulation models, or test run reports.
Seminar 3	Final Result & Deployment Plan	Present final test data, graphs, confusion matrices, performance comparison.

Syllabus
Design Refinement & Optimization – Efficiency, cost reduction, material change.
Testing under Real Conditions – Long-duration tests, cyclic/thermal loading, etc.
Economic & Sustainability Analysis – Life cycle costing, carbon footprint.
IP/Publication Drafting – Research paper, technical article, or patent application.
Final Report & Viva Preparation – Poster making, oral defense skills.