

Amrutvahini Sheti and Shikshan Vikas Sanstha's
AMRUTVAHINI COLLEGE OF ENGINEERING, SANGAMNER
(An Autonomous Institute Approved by AICTE and Affiliated to SPPU, Pune)
Amrutnagar, Ghulewadi, Sangamner – 422608



Curriculum Structure
of
B. Tech. Mechanical Engineering
Batch: 2025 - 2029




Chairman
BoS, Mechanical Engineering
Amrutvahini College of Engineering, Amrutnagar
Sangamner-422608




Chairman
Academic Council
Amrutvahini College of Engineering, Amrutnagar
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Preamble

The undergraduate curriculum structure has been designed in accordance with the National Education Policy (NEP) 2020 and the credit framework prescribed through the relevant Government Resolution (GR). The four-year undergraduate programme follows a semester-wise credit distribution that provides a balanced combination of Programme Core Courses, Programme Elective Courses, Multidisciplinary Courses, Ability Enhancement Courses, Vocational Skill Enhancement Courses, Open Electives, and experiential learning components. The structure ensures flexibility, multidisciplinary learning, skill development, and progressive attainment of programme-specific competencies while adhering to the prescribed credit requirements for each semester and the overall four-year undergraduate programme.

1. Credit Definition

The credit system adopted for the B.Tech. Mechanical Engineering programme is based on the guidelines prescribed under the **NEP 2020 framework for undergraduate engineering programmes**. The following definitions are used for determining the credits assigned to theory, tutorial and practical components of a course.

Table 1: Credit Definition and Contact Hours

Academic Component	Contact Hours per Week	Credits
Lecture (L)	1 Hour	1 Credit
Tutorial (T)	1 Hour	1 Credit
Practical (P)	2 Hours	1 Credit

2. Programme Credit Requirement

As per the Government of Maharashtra guidelines for implementation of NEP 2020 in undergraduate engineering programmes, the four-year B.E./B.Tech. programme with a Multidisciplinary Minor carries a prescribed credit range of **160 to 176 credits**. The Institute has adopted a total of **168 credits** for the four-year B.Tech. Mechanical Engineering programme, which falls within the prescribed range.

3. Semester-wise Credit Distribution

The following table presents the semester-wise credit distribution adopted for the four-year B.Tech. Mechanical Engineering programme. The credit load is planned within the **20–22 credit range prescribed per semester** under the NEP 2020 framework.

Table 2 -Semester-wise total credits

Year	Semester	Credits
First Year	Semester I	22
	Semester II	22
Second Year	Semester III	22
	Semester IV	22
Third Year	Semester V	20
	Semester VI	20



Fourth Year	Semester VII	20
	Semester VIII	20
Total		168

4. Category-wise Credit Distribution

The following table presents the distribution of the total programme credits across various course categories. It compares the credit ranges prescribed under the NEP 2020 framework with the credits adopted by the Institute for the B.Tech. Mechanical Engineering programme.

Table 3 – Categorywise Credit Distribution

Sr. No.	Course Category	Credits as per NEP Guidelines	Proposed Credits	Share of total Credits (%)
1	Basic Sciences (BSC)	14 – 18	16	9.52
2	Engineering Sciences (ESC)	12 – 16	15	8.93
3	Program Core Courses and Labs (PCC)	44 – 56	53	31.55
4	Program Electives and Labs (PEC)	20	17	10.11
5	Multidisciplinary Courses and Labs (MDM)	14	15	8.92
6	Open Electives (OEC)	8	6	3.57
7	Vocational Skill Enhancement Courses (VSEC)	8	8	4.76
8	Ability Enhancement Courses (AEC)	4	4	2.38
9	Indian Knowledge System (IKS)	2	2	1.19
10	Co-curricular Courses (CC)	4	2	1.19
11	Entrepreneurship/Economics/Management (EEM)	4	4	2.38
12	Value Education Courses (VEC)	4	4	2.38
13	Community Engagement Project (CEP)	2	2	1.19
14	Research Methodology (RSM)	4	4	2.38
15	Major Project (PRJ)	4	4	2.38
16	Internship / OJT (INT)	12	12	7.14
		160–176	168	100%



5. Alignment with NEP 2020 Credit Framework

The B.Tech. Mechanical Engineering programme of the Institute has been structured in alignment with the NEP 2020 Credit and Multidisciplinary Curricular Framework prescribed by the Government of Maharashtra. The Institute has adopted a total of 168 credits for the four-year programme, within the prescribed credit range of 160–176 credits for a four-year B.E./B.Tech. programme with a Multidisciplinary Minor. The curriculum incorporates Programme Core Courses, Programme Electives, Multidisciplinary Minor, Open Electives, Skill Enhancement Courses, Ability Enhancement Courses, Value Education, Internship, Project and other experiential learning components. The following table presents the credit distribution adopted by the Institute across various course categories.

Table 4 - Semester-wise Credit Distribution

Course Category	Sem I	Sem II	Sem III	Sem IV	Sem V	Sem VI	Sem VII	Sem VIII	Total Credits
Basic Science Courses (BSC)	8	8	-	-	-	-	-	-	16
Engineering Science Courses (ESC)	9	6	-	-	-	-	-	-	15
Programme Core Courses (PCC)	-	3	11	10	11	8	10	-	53
Programme Elective Courses (PEC)	-	-	-	-	4	7	2	4	17
Multidisciplinary Minor (MDM)	-	-	3	2	3	3	2	2	15
Open Electives (OE)	-	-	2	2	2	-	-	-	6
Vocational & Skill Enhancement Courses (VSEC)	2	2	-	2	-	2	-	-	8
Ability Enhancement Course (AEC)	2	-	-	2	-	-	-	-	4
Humanities, Social Science & Management (HSSM)	-	-	2	2	-	-	-	-	4
Indian Knowledge System (IKS)	-	2	-	-	-	-	-	-	2
Value Education Course (VEC)	-	-	2	2	-	-	-	-	4
Research Methodology (RM)	-	-	-	-	-	-	4	-	4
Community / Field Project	-	-	2	-	-	-	-	-	2
Project (DP)	-	-	-	-	-	-	2	2	4
Internship / OJT	-	-	-	-	-	-	-	12	12
Co-curricular / Liberal Courses	1	1	-	-	-	-	-	-	2
Total Credits	22	22	22	22	20	20	20	20	168

The following figure presents the distribution of programme credits across various course categories in the B.Tech. Mechanical Engineering programme. It provides a visual representation of the relative contribution of each category to the overall curriculum structure.

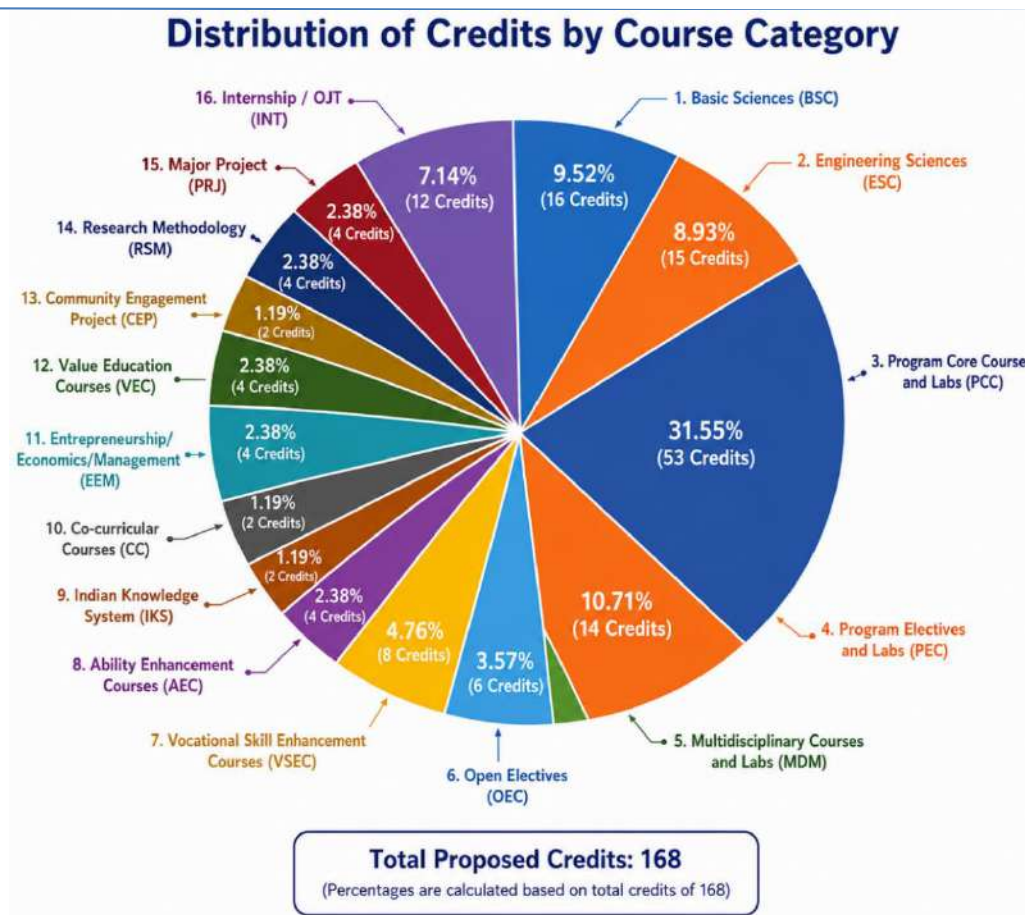


Fig 1 – Credit distribution by course category

The Institute offers multiple academic pathways within the four-year B.Tech. programme, providing students with flexibility to pursue multidisciplinary learning, advanced specialization, and research-oriented studies. The credit requirements for the different pathways are as follows

Table 5: Academic Pathways and Credit Requirements for B.Tech. Mechanical Engineering

Programme Nomenclature	Credits	Main requirement
B.Tech. in Mechanical Engineering	168 credits	Completion of the approved regular curriculum, project and internship/OJT.
B.Tech. in Mechanical Engineering - Honors	168 regular credits + 18 Honors credits = Total 186 Credits	Six approved Honors courses across Semesters III-VIII.
B.Tech. in Mechanical Engineering - Double Minor	168 regular credits + 18 credits of specialization Minor = Total 186 Credits	Six approved Honors courses across Semesters III-VIII.
B.Tech. in Mechanical Engineering - Honors with Research	168 regular credits + 18 Honors with Research credits = Total 186 Credits	Approved fourth-year research-specific courses and a Research Project/Dissertation.



6. Multiple Entry and Multiple Exit – Credit Requirements

The NEP 2020 framework provides flexibility for students to exit the four-year undergraduate programme at specified stages after successful completion of the prescribed academic requirements. The following table presents the qualification/award, credit requirements, semester, and year of completion as adopted for the B.Tech. Mechanical Engineering programme of the Institute.

Table 5 - Credit Requirements for Multiple Entry and Exit

Level	Qualification / Exit Award	Credit Requirements	Semester	Year
4.5	One-Year UG Certificate in Engineering/Technology	44	II	1
5.0	Two-Year UG Diploma in Engineering/Technology	88	IV	2
5.5	Three-Year Bachelor's Degree in Engineering/Technology	128	VI	3
6.0	Four-Year Bachelor's Degree (B.Tech.) with Multidisciplinary Minor	168	VIII	4

The following provisions shall apply to students who choose to exit the four-year B.Tech. programme after successful completion of an even semester.



B. Tech in Mechanical Engineering

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Sr. No.	Course Code	Course Type	Course Name	Teaching Scheme (Hrs./week)						Examination Scheme and Marks						Credit			
				TH	PR	TUT	Contact Hours	Self Learning	Total	CCE	ESE	TW	PR	OR	TOTAL	TH	PR	TUT	TOTAL
Semester-I																			
1	R25-SH-BSC-101	Basic Science Course	Linear Algebra and Calculus	4	-	-	60	60	120	40	60	-	-	-	100	4			4
2	R25-SH-BSC-103	Basic Science Course	Engineering Chemistry	3	2	-	45	45	120	40	60	25	-	-	125	3	1		4
3	R25-ME-ESC-104	Engineering Science Course	Systems of Mechanical Engineering	3	-	-	45	45	90	40	60	-	-	-	100	3			3
4	R25-EE-ESC-106	Engineering Science Course	Fundamentals of Electrical Engineering	2	2	-	30	30	90	40	60	25	-	-	125	2	1		3
5	R25-CO-ESC-108	Engineering Science Course	Programming & Problem Solving Using Python	2	2	-	30	30	90	40	60	25	-	-	125	2	1		3
6	R25-ME-VSEC-109	Vocational & Skill Enhancement Course	Engineering Workshop Skills Lab	-	2	-	30	-	30	-	-	50	-	-	50		1		1
7	R25-ME-VSEC-110	Vocational & Skill Enhancement Course	Engineering Graphics Lab	-	2	-	30	-	30	-	-	50	-	-	50		1		1
8	R25-SH-AEC-113	Ability Enhancement Course	Indian Knowledge System	-	-	2	30	30	60	-	-	50	-	-	50			2	2
9	R25-SH-CC-114	Cocurricular Courses	Cocurricular Courses - I	-	2	-	30	-	30	-	-	25	-	-	25		1		1
			Total	14	12	2	330	240	660	200	300	250	0	0	750	14	6	2	22



Sr. No.	Course Code	Course Type	Course Name	Teaching Scheme (Hrs./week)						Examination Scheme and Marks						Credit			
				TH	PR	TUT	Contact Hours	Self Learning Hours	Total	CCE	ESE	TW	PR	OR	TOTAL	TH	PR	TUT	TOTAL
Semester-II																			
1	R25-SH-BSC-116	Basic Science Course	Advanced Calculus and Numerical Integration	4	-	-	60	60	120	40	60	-	-	-	100	4			4
2	R25-SH-BSC-102	Basic Science Course	Engineering Physics	3	2	-	45	45	120	40	60	25	-	-	125	3	1		4
3	R25-CE-ESC-105	Engineering Science Course	Engineering Mechanics and Civil Engineering Systems	3	-	-	45	45	90	40	60	-	-	-	100	3			3
4	R25-ET-ESC-107	Engineering Science Course	Fundamentals of Electronics Engineering	2	2	-	30	30	90	40	60	25	-	-	125	2	1		3
5	R25-CO-PCC-118	Program Core Course	Emerging Trends in Mechanical Engineering	2	-	-	30	30	60	40	60	-	-	-	100	2			2
6	R25-IT-PCC-119	Program Core Course Lab	Programming in C Lab	-	2	-	30		30	-	-	25	-	-	25		1		1
7	R25-CO-VSEC-115	Vocational & Skill Enhancement Course	Digital Technology Lab	-	2	-	30	-	30	-	-	50	-	-	50		1		1



8	R25-CE-VSEC-111	Vocational & Skill Enhancement Course	Civil Engineering Lab	-	2	-	30	-	30	-	-	50	-	-	50		1		1
9	R25-SH-AEC-112	Indian Knowledge System	Professional Communication Skill or Foreign Language (Japanese/German)	-	-	2	30	30	60	-	-	50	-	-	50			2	2
10	R25-SH-CC-117	Cocurricular Courses	Cocurricular Courses - II	-	2		30	-	30	-	-	25	-	-	25		1		1
Total				14	12	2	360	240	660	200	300	250	0	0	750	14	6	2	22

Exit option: Award of UG Certificate in Major with 44 credits and an additional 8 credits from following Exit Courses

Course Code	Course Title	L	T	P	Credits	Contact Hrs	TW	OR	Total Marks
R25-ME-EXC-101A	Manufacturing & Workshop Skills	—	—	—	4	—	100		100
R25-ME-EXC-101B	Project	—	—	16	4	16	50	50	100
Total									200



Sr. No.	Course Code	Course Type	Name of the Subject	Teaching Scheme (Hrs./week)						Examination Scheme and Marks						Credit			
				TH	PR	TUT	Contact Hours	Self Learning	Total	CCE	ESE	TW	PR	OR	TOTAL	TH	PR	TUT	TOTAL

Semester-III

1	R25-ME-PCC-201	Program Core course - 1	Solid Mechanics	3	-	-	45	45	90	40	60	-	-	-	100	3	-	-	3
2	R25-ME-PCC-202	Program Core course - 2	Engineering Thermodynamics	3	-	-	45	45	90	40	60	-	-	-	100	3	-	-	3
3	R25-ME-PCC-203	Program Core course - 3	Engineering Materials & Metallurgy	3	-	-	45	45	90	40	60	-	-	-	100	3	-	-	3
4	R25-ME-MDM-204	Multidisciplinary Course-1	Computational and Statistical Methods	3	-	-	45	45	90	40	60	-	-	-	100	3	-	-	3
5	R25-ME-OEC-205	Open Elective - 1	To be chosen from a basket of Open Elective- I finalized at college level	2	-	-	30	30	60	40	60	-	-	-	100	2	-	-	2
6	R25-ME-HSSM-206	Entrepreneurship/Economics/ Management course	Entrepreneurial Thinking and Innovation	1	2	-	15	15	60	25	-	25	-	-	50	1	1	-	2
7	R25-ME-VEC-207	Value Education Course	Professional Ethics and Human Values	2	-	-	30	30	60	50	-	-	-	-	50	2	-	-	2
8	R25-ME-PCC-208	Program Core Course-Lab	Material Testing and Characterization Lab	-	2	-	-	-	30	-	-	25	25	-	50	-	1	-	1
9	R25-ME-PCC-209	Program Core Course Lab / Multidisciplinary Course-Lab	GD&T and Geometric Modelling Lab	-	2	-	-	-	30	-	-	25	25	-	50	-	1	-	1
10	R25-ME-CEP-210	Community Engagement Project / Field Project	Community Engagement Project	-	4	-	-	-	60	-	-	50	-	-	50	-	2	-	2
				17	10	0	255	255	660	275	300	125	50	0	750	17	5	0	22



Note: Open Elective basket and MDM Courses offered at college level, are enlisted after Sem-VIII.

Semester-IV																			
Sr. No.	Course Code	Course Type	Name of the Subject	Teaching Scheme (Hrs./week)						Examination Scheme and Marks						Credit			
				TH	PR	TUT	Contact Hours	Self Learning	Total	CCE	ESE	TW	PR	OR	TOTAL	TH	PR	TUT	TOTAL
1	R25-ME-PCC-211	Program Core course - 4	Fluid Mechanics	3	-	-	45	45	90	40	60	-	-	-	100	3	-	-	3
2	R25-ME-PCC-212	Program Core course - 5	Manufacturing Processes-I	2	-	-	30	30	60	40	60	-	-	-	100	2	-	-	2
3	R25-ME-PCC-213	Program Core course - 6	Applied Thermodynamics	3	-	-	45	45	90	40	60	-	-	-	100	3	-	-	3
4	R25-ME-MDM-214	Multidisciplinary Course - 2	Mechatronics	2	-	-	30	30	60	40	60	-	-	-	100	2	-	-	2
5	R25-ME-OEC-215	Open Elective - 2	To be chosen from a basket of Open Elective- II finalized at college level	2	-	-	30	30	60	40	60	-	-	-	100	2	-	-	2
6	R25-ME-VSC-216	Vocational Skill Course	Workshop Practice	1	2	-	15	15	60	25	-	-	25	-	50	1	1	-	2
7	R25-ME-AEC-217	Ability Enhancement Course	Modern Indian Language and Technical Writing	1	2	-	15	15	60	25	-	25	-	-	50	1	1	-	2
8	R25-ME-EEM-218	Entrepreneurship/Economics/ Management course	Entrepreneurship and Financial Management	2	-	-	30	30	60	50	-	-	-	-	50	2	-	-	2



9	R25-ME-PCC-219	Program Core Course-Lab	Mechatronics and IOT Lab	-	2	-	30	-	30	-	-	-	25	-	25	-	1	-	1
10	R25-ME-PCC-220	Program Core Course Lab	Thermo-Fluid Lab	-	2	-	30	-	30	-	-	-	25	-	25	-	1	-	1
11	R25-ME-VEC-221	Value Education Course	Green Technologies and Sustainable Development	2	-	-	30	30	60	50	-	-	-	-	50	2	-	-	2
				18	8	0	330	270	660	350	300	25	75	0	750	18	4	0	22

Exit option: Award of UG Diploma in Major with 88 credits and an additional 8 credits from following Exit Courses

Course Code	Course Title	L	T	P	Credits	Contact Hrs	TW	OR	Total Marks
R25-ME-EXC-101A	CNC and 3D Printing	-	-	-	4	-	100		100
R25-ME-EXC-101B	Project	-	-	16	4	16	50	50	100
Total									200



Course Code	Course Type	Course Name	Teaching Scheme (Hrs./week)						Examination Scheme and Marks						Credit			
			TH	PR	TUT	Contact Hours	Self-Learning Hours	Total	CCE	ESE	TW	PR	OR	TOTAL	TH	PR	TUT	TOTAL
Semester-V																		
R25-ME-PCC-301	Program Core course - 7	Design of Machine Elements	3			45	45	90	40	60				100	3			3
R25-ME-PCC-302	Program Core course - 8	Manufacturing Process-II	3			45	45	90	40	60				100	3			3
R25-ME-PCC-303	Program Core course - 9	Kinematics of Machines	3			45	45	90	40	60				100	3			3
R25-ME-PEC-304	Program Elective Course - I	Program Elective-I	3			45	45	90	40	60				100	3			3
R25-ME-MDM-305	Multidisciplinary Course-3	Artificial Intelligence and Machine Learning	2			30	30	60	50					50	2			2
R25-ME-OEC-306	Open Elective - III	To be chosen from a basket of Open Elective- III finalized at college level	2			30	30	60	40	60				100	2			2
R25-ME-PCC-307	Program Core Course Lab	Industrial Robotics Lab		2		30		30				50		50		1		1
R25-ME-PCC-308	Program Core Course Lab	Reverse Engineering and Tool Design Lab		2		30		30				50		50		1		1



R25-ME-PEC-309	Program Elective Course - I lab	Program Elective-I Lab		2		30		30					50	50		1		1
R25-ME-MDM-310	Multidisciplinary Course-3 Lab	Artificial Intelligence and Machine Learning Lab		2		30		30			50			50		1		1
			16	8	0	360	240	600	250	300	50	100	50	750	16	4	0	20

Semester-VI

Sr. No.	Course Code	Course Type	Course Name	Teaching Scheme (Hrs./week)						Examination Scheme and Marks						Credit			
				TH	PR	TUT	Contact Hours	Self Learning	Total	CCE	ESE	TW	PR	OR	TOTAL	TH	PR	TUT	TOTAL
1	R25-ME-PCC-311	Program Core course - 10	Heat & Mass Transfer	3			45	45	90	40	60				100	3			3
2	R25-ME-PCC-312	Program Core course - 11	Metrology and Quality Control	3			45	45	90	40	60				100	3			3
3	R25-ME-PEC-313	Program Elective -II	Program Elective- II	3			45	45	90	40	60				100	3			3
4	R25-ME-PEC-314	Program Elective -III	Program Elective - III	3			45	45	90	40	60				100	3			3
5	R25-ME-MDM-315	Multidisciplinary Course-4	Computer Aided Engineering	2			30	30	60	40	60				100	2			2



6	R25-ME-PCC-316	Program Core Course Lab	Heat & Mass Transfer Lab		2		30		30					50	50		1		1
7	R25-ME-PCC-317	Program Core Course Lab	Digital Manufacturing Lab		2		30		30				50		50		1		1
8	R25-ME-PEC-318	Program Elective -II lab	Program Elective- II Lab		2		30		30					50	50		1		1
9	R25-ME-MDM-319	Multidisciplinary Course Lab	Computer Aided Engineering Lab		2		30		30					50	50		1		1
10	R25-ME-VSC-320	Vocational and Skill Enhancement Course	Hydraulics and Pneumatics: Industrial Applications		2		30		30				25		25		1		1
11	R25-ME-VSC-321	Vocational and Skill Enhancement Course	World Class Manufacturing Practices and Industrial Skills		2		30		30			25			25		1		1
				14	12	0	390	210	600	200	300	25	75	150	750	14	6	0	20
		Program Elective-I		Program Elective-II															
		R25-ME-PEC-304 A	Industrial Engineering	R25-ME-PEC-313 A				Additive Manufacturing											
		R25-ME-PEC-304 B	Turbo Machinery	R25-ME-PEC-313 B				Steam Engineering and Energy Conservation											
		R25-ME-PEC-304 C	Tribology and Surface Engineering	R25-ME-PEC-313 C				Design for X											
		R25-ME-PEC-304 D	Computer Oriented Numerical Methods	R25-ME-PEC-313 D				Electric and Hybrid Vehicles											
		Program Elective-III																	
		R25-ME-PEC-314 A	Advance Manufacturing																



	Processes	
R25-ME-PEC-314 B	Automobile Engineering	
R25-ME-PEC-314 C	Advanced Materials and Composites	
R25-ME-PEC-314 D	Robotics and Industrial Automation	

Exit option: Award of UG Diploma in Major with 128 credits and an additional 8 credits from following Exit Courses

Course Code	Course Title	L	T	P	Credits	Contact Hrs	TW	OR	Total Marks
R25-ME-EXC-301A	Quality Engineering	–	–	–	4	–	100		100
R25-ME-EXC-301B	Project	–	–	16	4	16	50	50	100
Total									200



Sr. No.	Course Code	Course Type	Course Name	Teaching Scheme (Hrs./week)						Examination Scheme and Marks						Credit			
				TH	PR	TUT	Contact Hours Self Learning Hours	Total	CCE	ESE	TW	PR	OR	TOTAL	TH	PR	TUT	TOTAL	
	Semester-VII																		
1	R25-ME-PCC-401	Program Core course - 12	Dynamics of Machinery	3			45	45	90	40	60				100	3			3
2	R25-ME-PCC-402	Program Core course - 13	Heating, Ventilation and Air Conditioning	3			45	45	90	40	60				100	3			3
3	R25-ME-PCC-403	Program Core course - 14	Transmission System Design	2			30	30	60	40	60				100	2			2
4	R25-ME-PEC-404	Program Elective -IV	Program Elective - IV (Enlisted below)	2			30	30	60	40	60				100	2			2
5	R25-ME-MDM-405	Multidisciplinary Course-5	Computer Integrated Manufacturing	2			30	30	60	40	60				100	2			2
6	R25-ME-RSM-406	Research methodology	Research methodology	3	2		45	45	120	50		50			100	3	1		4
7	R25-ME-PCC-407	Program Core course Lab	Dynamics of Machinery Lab		2				30					50	50		1		1
8	R25-ME-PCC-408	Program Core course Lab	Heating, Ventilation and Air Conditioning Lab		2				30				50		50		1		1
9	R25-ME-PRJ-409	Project	Project Stage - I		4				60			50			50		2		2



				15	10	0	225	225	600	250	300	100	50	50	750	15	5	0	20
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Semester-VIII

Sr. No.	Course Code	Course Type	Course Name	Teaching Scheme (Hrs./week)						Examination Scheme and Marks						Credit			
				TH	PR	TUT	Contact Hours	Self Learning Hours	Total	CCE	ESE	TW	PR	OR	TOTAL	TH	PR	TUT	TOTAL
1	R25-ME-PEC-410	Program Elective -V	Program Elective -V (Enlisted below: Complete online course on SWAYAM NPTEL) - 8 to 12 Weeks	2				30	30	40	60*				100	2			2
2	R25-ME-PEC-411	Program Elective -VI	Program Elective -VI (Enlisted below: Complete online course on SWAYAM NPTEL) - 8 to 12 Weeks	2				30	30	40	60*				100	2			2
3	R25-ME-MDM-412	Multidisciplinary Course-6	Smart Manufacturing and Industry 4.0	2			30	30	60	40	60				100	2			2
4	R25-ME-PRJ-413	Project	Project Stage - II	-	-	-		60	60			100		50	150		2		2
5	R25-ME-INT-414	Internship/OJT	Internship	-	-	-		360	360			200		100	300		12		12
				6	0	0	30	510	540	120	60	300	0	150	750	6	14	0	20



Program Elective -IV		Program Elective -V	
R25-ME-PEC-404 A	Energy Storage Technologies	R25-ME-PEC-410 A	Electronic Component Manufacturing
R25-ME-PEC-404 B	Mechanical System Design	R25-ME-PEC-410 B	Computational Fluid Dynamics
R25-ME-PEC-404 C	Predictive Maintenance and Reliability Engineering	R25-ME-PEC-410 C	Product Design and Development
R25-ME-PEC-404 D	Opeartions Research	R25-ME-PEC-410 D	Digital Twin and Cyber-Physical Systems
Program Elective -VI			
R25-ME-PEC-411 A	Energy Management and Auditing		
R25-ME-PEC-411 B	Aucaustic and Acoustic Materials		
R25-ME-PEC-411 C	Product Lifecycle Management		
R25-ME-PEC-411 D	Optimization Techniques		

**Open Elective Courses:**

In accordance with the principles of NEP 2020, Open Elective (OE) courses provide students with an opportunity to acquire knowledge beyond their major discipline and promote multidisciplinary and interdisciplinary learning. Students can choose courses offered by other disciplines/programmes according to their interests, subject to the prescribed credit requirements and availability. The Open Elective Basket is designed to provide flexibility in academic choices and enable students to develop broader knowledge and skills relevant to their personal, professional, and career interests.

Table 6 – Open Elective Course Baskets

Sr. No.	Open Elective subject offered by Department	Semester III	Semester IV
1.	Artificial Intelligence and Data Science	Road Safety and Civic Responsibility	Digital Marketing and E-business
2.	Automation and Robotics	Supply Chain Management	Farm Automation
3.	Civil Engineering	Mechanical Electrical and Plumbing Systems	Interior Design
4.	Computer Engineering	Financial Literacy and Investment Planning	Digital Governance and Management Information Systems
5.	Electrical Engineering	Project Management	Sustainable Rural Entrepreneurship and Development
6.	Electronics and Computer Engineering	Leadership and Organizational Behaviour	Dairy and Food Process Technology
7.	Electronics and Telecommunication Engineering	Business Analytics	Remote Sensing and GIS
8.	Information Technology	Cyber Security and Laws	Data Ethics and Visualization
9.	Mechanical Engineering	Principles and Practices of Management	Agri-Tech Systems

Multidisciplinary Minor Courses:

A Multidisciplinary Minor (MDM) is a structured set of courses that allows students to gain additional knowledge and skills in a discipline other than their major/branch of study. It promotes interdisciplinary learning and enables students to apply concepts from multiple fields to solve real-world problems. Each department shall offer one multidisciplinary minor course in every semester from Semester III to Semester VIII. The courses offered under the Multidisciplinary Minor shall be proposed and approved by the Board of Studies (BoS) of the respective offering department.



Table 7 – List of MDMs offered by different department

MDM Offered by Department	Sr. No.	Course Code	Course Name	Semester
Artificial Intelligence and Data Science	1	R25-AI-MDM-204	Foundational Mathematics for AI & DS	III
	2	R25-AI-MDM-214	Embedded System & Internet of Things	IV
	3	R25-AI-MDM-305	Image processing	V
	4	R25-AI-MDM-315	Robotics & Automation	VI
	5	R25-AI-MDM-403	Computer Vision	VII
	6	R25-AI-MDM-411	Industrial IOT	VIII
Automation and Robotics	1	R25-AR-MDM-204	Applied Mathematics	III
	2	R25-AR-MDM-214	Data Science & Visualization	IV
	3	R25-AR-MDM-305	ROS	V
	4	R25-AR-MDM-315	Advanced Manufacturing Technology	VI
	5	R25-AR-MDM-405	Applied Data Analytics	VII
	6	R25-AR-MDM-204	Applied Mathematics	VIII
Civil Engineering	1	R25-CE-MDM-204	Computational and Applied Mathematics	III
	2	R25-CE-MDM-214	Digital Modelling and Visualization	IV
	3	R25-CE-MDM-305	Geospatial Technologies and Spatial Analytics	V
	4	R25-CE-MDM-315	Data Analytics and Digital Information	VI
	5	R25-CE-MDM-405	Artificial Intelligence and Machine Learning	VII
	6	R25-CE-MDM-412	AI, IoT and Digital Twin	VIII
Computer Engineering	1	R25-CO-MDM-204	Probability and Statistics	III
	2	R25-CO-MDM-214	Embedded Systems & Internet of Things	IV
	3	R25-CO-MDM-305	Smart Communication Technologies	V
	4	R25-CO-MDM-315	Signal Processing for Intelligent Systems	VI
	5	R25-CO-MDM-403	Edge Computing & Cyber Systems	VII
	6	R25-CO-MDM-411	Intelligent Autonomous Systems	VIII
Electrical Engineering	1	R25-EE-MDM-204	Applied Mathematics	III
	2	R25-EE-MDM-215	Principles of Data Science & Machine Learning	IV
	3	R25-EE-MDM-305	Foundations of Artificial	V



			Intelligence	
	4	R25-EE-MDM-315	Evolutionary Algorithms and Optimization	VI
	5	R25-EE-MDM-405	Deep Learning	VII
	6	R25-EE-MDM-412	Intelligent Electrical Systems and Applications	VIII
Electronics and Computer Engineering	1	R25-EC-MDM-204	Fundamentals of IoT	III
	2	R25-EC-MDM-215	Applied Mathematics	IV
	3	R25-EC-MDM-304	Programming for IoT Systems	V
	4	R25-EC-MDM-315	Embedded Systems for Robotics	VI
	5	R25-EC-MDM-405	Robotics and Automation	VII
	6	R25-EC-MDM-412	Industry 4.0 and smart manufacturing (online mode)	VIII
Electronics and Telecommunication Engineering	1	R25-ET-MDM-204	Data Structures and Algorithms	III
	2	R25-ET-MDM-214	Object Oriented Programming with Java	IV
	3	R25-ET-MDM-305	Advanced Java Programming	V
	4	R25-ET-MDM-315	Database Management Systems	VI
	5	R25-ET-MDM-405	Web Technologies and Full Stack Development	VII
	6	R25-ET-MDM-412	Cloud Computing and DevOps	VIII
Information Technology	1	R25-IT-MDM-204	Digital Electronics and Logic Design	III
	2	R25-IT-MDM-214	Applied Mathematics	IV
	3	R25-IT-MDM-305	Industrial Internet of Things (IoT)	V
	4	R25-IT-MDM-315	Augmented and Virtual Reality	VI
	5	R25-IT-MDM-405	Wireless Communication	VII
	6	R25-IT-MDM-412	Digital Transformation and Industry 5.0	VIII
Mechanical Engineering	1	R25-ME-MDM-204	Computational and Statistical Methods	III
	2	R25-ME-MDM-214	Mechatronics	IV
	3	R25-ME-MDM-305	Artificial Intelligence and Machine Learning	V
	4	R25-ME-MDM-315	Computer Aided Engineering	VI
	5	R25-ME-MDM-403	Computer Integrated Manufacturing	VII
	6	R25-ME-MDM-411	Smart Manufacturing and Industry 4.0	VIII



B.Tech. in Mechanical Engineering - Honors

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**Honor Courses:**

Students who wish to pursue an Honors qualification shall complete additional courses carrying a minimum of 18 credits over and above the 168 credits prescribed for the regular B.Tech. programme.

Thus, for the award of B.Tech. with Honors, a student shall successfully earn a minimum total of 186 credits, comprising:

- 168 credits prescribed under the regular B.Tech. programme, and
- 18 additional credits through the Honor courses.

The Department of Mechanical Engineering offers an Honors Track in Lean manufacturing (18 Credits) to provide students with advanced and specialized knowledge and skills in the field of world class manufacturing.

Table 8 – Honors in Lean Manufacturing

Year	Semester	Course Code	Course Name	Credits
Second Year	Sem III	R25-ME-HOC-201	Foundations of Lean Manufacturing	3
	Sem IV	R25-ME-HOC-202	Toyota Production System	3
Third Year	Sem V	R25-ME-HOC-301	Manufacturing Strategy	3
	Sem VI	R25-ME-HOC-302	Lean Management and Six Sigma	3
Final Year	Sem VII	R25-ME-HOC-401	Advanced Lean Manufacturing	3
	Sem VIII	R25-ME-HOC-402	Sustainability through Green Manufacturing Systems	3
Total				18



B. Tech. in Mechanical Engineering- Double Minor

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**Double Minor Course:**

- The Double Minor provides an opportunity for students to gain additional knowledge and skills in a discipline other than their parent programme.
- The department offers its approved Honors specialization/course basket as a Double Minor to eligible students from other departments.
- A student opting for a Double Minor shall complete six prescribed courses, each carrying 3 credits, for a total of 18 additional credits.
- The courses shall be completed from Semester III to Semester VIII.
- The courses shall be completed along with the regular B.Tech. programme and shall follow the prescribed sequence and prerequisites, wherever applicable.
- On successful completion of all the prescribed courses and earning the required 18 credits, the student shall be eligible for the award of a Double Minor in the respective specialization/track, as per the academic regulations of the institution.

Table – Double Minor

Year	Semester	Course Code	Course Name	Credits
Second Year	Sem III	R25-XX-DMC-201	Double Minor Course - I	3
	Sem IV	R25-XX-DMC-202	Double Minor Course – II	3
Third Year	Sem V	R25-XX-DMC-301	Double Minor Course – III	3
	Sem VI	R25-XX-DMC-302	Double Minor Course – IV	3
Final Year	Sem VII	R25-XX-DMC-401	Double Minor Course – V	3
	Sem VIII	R25-XX-DMC-402	Double Minor Course - VI	3
Total				18

The following tracks are offered by the respective departments under the Honors/Double Minor Programme.

Eligible students shall choose the track offered by their parent/offering department as an Honors Course. **The same track shall be available to eligible students of other departments as a Double Minor.**

Sr. No.	Offering Department	Track Offered
1	Artificial Intelligence & Data Science	Advanced Artificial Intelligence and Data Science
2	Automation & Robotics	Industrial Robotics and Intelligent Automation
3	Civil Engineering	Architecture and Town Planning



Sr. No.	Offering Department	Track Offered
4	Computer Engineering	Advanced Artificial Intelligence
5	Electronics & Computer Engineering	Semiconductor Manufacturing and Chip Technology
6	Electronics & Telecommunication	Intelligent and Emerging Communication Technologies
7	Electrical Engineering	Electric Vehicles
8	Information Technology	Cyber Security
9	Mechanical Engineering	Lean Manufacturing

**For more details, please refer to the track of honor courses provided by other departments.*



B. Tech. in Mechanical Engineering – Honors with Research

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**Honors with research:**

The Student will work on a Research Project or Dissertation for 18 Credits in the Fourth Year in the respective discipline other than regular academic project at final year.

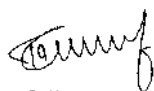
- The distribution of 18 Credits for Research projects in Sem-VII and Sem-VIII is given below.
- To get a B.Tech. in Mechanical Engineering with Multidisciplinary Minor and Research Honors - Students need to earn a total of 186 Credits which consist of 168 credits of regular Multidisciplinary Minor courses, 18 Credits of Honor with Research courses.

Course Code	Course Type	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks				Credit			
			TH	PR	TUT	CCE	ESE	TW	TOTAL	TH	PR	TUT	TOTAL
Sem -VII (HRC)													
R25-ME-HRC-401	Honors With Research	Intellectual Property Right (IPR)	2	-	-	50	50	-	100	2		-	2
R25-ME-HRC-402	Honors With Research	Research Project Phase-I	-	4	-	-	-	50	50	-	2	-	2
R25-ME-HRC-403	Honors With Research	Research Specific Core Course-I (Online NPTEL Course#)	3	-	-	50	50	-	100	3	-	-	3
			5	4		100	100	50	250	3	4		7

Course Code	Course Type	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks				Credit			
			TH	PR	TUT	CCE	ESE	TW	TOTAL	TH	PR	TUT	TOTAL
Sem -VII (HRC)													
R25-ME-HRC-404	Honors With Research	Research Project Phase-II		22	-			50	50	-	11	-	11
				22				50	50		11		11

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Abbreviations

AEC - Ability Enhancement Course
AICTE - All India Council for Technical Education
CEP - Community Engagement Project
EEM - Entrepreneurship/Economics/Management Courses
MDM - Multidisciplinary Minor
MOOC - Massive Open Online Course
NEP - National Education Policy
NPTEL - National Programme on Technology Enhanced Learning
OE - Open Elective
PCC - Program Core Course
CCC – Cocurricular Course
PEO - Programme Educational Objectives
PSO - Program Specific Outcomes
SWAYAM - Study Webs of Active-learning for Young Aspiring Minds
UGC - University Grants Commission
VEC - Value Education Course
VSE - Vocational and Skill Enhancement Course
WK - Knowledge and Attitude Profile
CCE - Comprehensive and Continuous Evaluation
ISO - International Organization for Standardization
EOMS - Educational Organization Management System

Institute Vision

To create opportunities for rural students to become able engineers and technocrats through continual excellence in engineering education.

Institute Mission

Our mission is to create self-disciplined, physically fit, mentally robust and morally strong engineers and technocrats with high degree of integrity and sense of purpose who are capable to meet challenges of ever advancing technology for the benefit of mankind and nature.

We, the management, the faculty and staff, therefore promise to strive hard and commit ourselves to achieve this objective through a continuous process of learning and appreciation of needs of time.

Department Vision

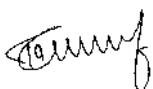
To transform rural students into competent Mechanical Engineers and technocrats with professional and social values through continual excellence in engineering education.

Department Mission

M1: To impart quality education and training that develop engineers to meet challenges of ever advancing needs of industry, higher learning and entrepreneurship for the benefit of mankind and nature.

M2: To be recognized as department of academic excellence through resource development, conducive teaching-learning environment, skill development, and innovation and industry-institute interaction. .

M3: To nurture professional and ethical values and life-long learning for successful career.



ISO 21001:2018 - EOMS Policy

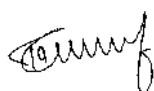
We, at AVCOE Sangamner, are committed to:

- Provide quality technical education to the rural students
- Provide conducive environment for all round development of the students.
- Develop as a premier institute for technical education & research as per the needs and expectations of all stake holders.
- Comply all applicable requirements.
- Develop students into technocrats having social responsibility.
- Keep abreast about the advances in technology and innovation.
- Enhance industry-institute interaction.
- Managing intellectual property.
- Maintain hygiene, health and safety for applicable requirements.
- Achieve continual improvement in academic and administrative processes.
- We shall strive to maintain Educational Organizational Management System.

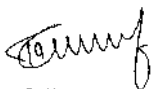
Knowledge and Attitude Profile

A Knowledge and Attitude Profile (KAP), often represented as WK (Knowledge and Attitude Profile) in some contexts, is a framework or assessment tool used to evaluate an individual's knowledge and attitudes related to a specific area, topic, or domain.

WK1	A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
WK2	Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
WK3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
WK4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
WK5	Knowledge, including efficient resource use, environmental impacts, whole- life cost, re-use of resources, net zero carbon, and similar Concepts, that supports engineering design and operations in a practice area.

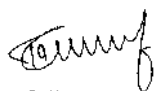


WK6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
WK7	Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
WK8	Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
WK9	Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.




Program Outcomes (POs)

PO1	Engineering knowledge	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	Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
PO3	Design / Development of Solutions	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	Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
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)




Program Educational Objectives (PEOs):

PEO1: Plan, design, manufacture, maintain and improve systems that are technically sound, economically feasible and socially acceptable in the field of Mechanical and allied industries.

PEO2: Solve problems of engineering and social relevance by applying knowledge of Mechanical engineering and advanced tools for sustainable development.

PEO3: Work effectively as individual and as team member in multidisciplinary projects, and demonstrate managerial and entrepreneurial skills.

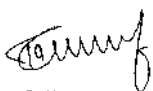
PEO4: Engage in lifelong learning, career enhancement and adopt to changing professional and societal needs.

Program Specific Outcomes (PSOs):

PSO1: Apply the knowledge, design procedures, mathematical and advance tools for the design and evaluation of mechanical components and systems.

PSO2: Demonstrate the ability to evaluate the performance of thermal and fluid systems for effective energy conversions.

PSO3: Select and apply appropriate manufacturing technologies and tools; and to develop competencies for working in manufacturing and allied industries.



Preface

It gives me immense pleasure to present the Curriculum of the Second Year B. Tech. in Mechanical Engineering, developed in accordance with the vision of the National Education Policy (NEP) 2020 and introduced under the autonomous framework of the institute.

The Second Year curriculum serves as the foundation of Mechanical Engineering education and is carefully designed to provide students with a strong understanding of the fundamental principles of mechanical sciences, engineering analysis, materials, manufacturing, thermal systems, fluid mechanics, and emerging multidisciplinary technologies. The curriculum aims to build a solid academic base while nurturing practical skills, problem-solving abilities, innovation, and professional competence required for modern engineering practice.

The syllabus integrates outcome-based education, experiential learning, laboratory practice, community engagement, entrepreneurship, ethics, sustainability, and multidisciplinary exposure. Courses such as Solid Mechanics, Engineering Thermodynamics, Engineering Materials and Metallurgy, Manufacturing Processes, Fluid Mechanics, Mechatronics, Computational and Statistical Methods, and skill-based laboratory courses provide students with the essential knowledge and technical skills required for advanced studies in Mechanical Engineering.

Special emphasis has been placed on industry relevance, digital technologies, Industry 4.0 concepts, design thinking, innovation, and lifelong learning. The inclusion of multidisciplinary courses, open electives, vocational skill development, entrepreneurship, professional ethics, green technologies, and community engagement projects ensures holistic development and prepares students to address real-world engineering challenges with responsibility and creativity.

The curriculum has been developed through extensive consultations with academicians, industry experts, alumni, employers, and members of the Board of Studies. Their valuable inputs have helped align the program with current industrial requirements, technological advancements, and future professional opportunities in sectors such as manufacturing, automotive, energy, automation, aerospace, sustainability, and emerging engineering domains.

I sincerely appreciate the dedicated efforts of all faculty members, subject experts, industry representatives, and Board of Studies members who contributed to the successful design and development of this curriculum. I am confident that this syllabus will provide students with a strong foundation in Mechanical Engineering, enhance their employability, encourage innovation and entrepreneurship, and prepare them to become competent, ethical, and socially responsible engineers.

I extend my best wishes to all students and faculty members for the effective implementation of this curriculum and for achieving excellence in teaching, learning, research, innovation, and professional practice.

Dr. V. D. Wakchaure

Prof. & Head, Department of Mechanical Engineering

Amrutvahini College of Engineering, Sangamner

(An Autonomous Institute affiliated to Savitribai Phule Pune University, Pune)

Program codes:

The institute has assigned a unique program code to each branch.

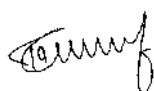
Table 1 – Program codes

Sr. No.	Program code	Code
UG Programs		
1	Mechanical Engineering	ME
PG Programs		
2	M. Tech (Mech- Design Engineering)	MME

Subject code nomenclature:

The following nomenclature demonstrates the subject codes:

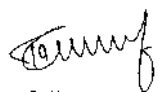
- **R-Year** (of designing/revising syllabus) – **Program code** (as given in table 1) - **Course Type** (as per NEP) – **Course Number** (101 – FY B. Tech Subject 1, 201 – SY B. Tech Subject 1, 301 – TY B. Tech Subject 1, 401 – B. Tech Subject 1 etc.)



Syllabus Structure: S. Y. B. Tech (Mechanical Engineering)

Course Code	Course Type	Name of the Subject	Teaching Scheme					Examination Scheme and Marks						Credit			
			(Hrs./week)			SL	Total	CCE	ESE	TW	PR	OR	TOTAL	TH	PR	TUT	TOTAL
			TH	PR	TUT												
Semester-III																	
R25-ME-PCC-201	Program Core course - 1	Solid Mechanics	3	–	–	45	90	40	60	–	–	–	100	3	–	–	3
R25-ME-PCC-202	Program Core course - 2	Engineering Thermodynamics	3	–	–	45	90	40	60	–	–	–	100	3	–	–	3
R25-ME-PCC-203	Program Core course - 3	Engineering Materials & Metallurgy	3	–	–	45	90	40	60	–	–	–	100	3	–	–	3
R25-ME-MDM-205	Multidisciplinary Course-1	Computational and Statistical Methods	3	–	–	45	90	40	60	–	–	–	100	3	–	–	3
R25-ME-OE-204	Open Elective - 1	Open Elective - 1	2	–	–	30	60	40	60	–	–	–	100	2	–	–	2
R25-ME-HSSM-206	Entrepreneurship/Economics/Management course	Entrepreurial Thinking and Innovation	1	2	–	15	60	50	–	–	–	–	50	1	1	–	2
R25-ME-EVC-207	Value Education Course	Professional Ethics and Human Values	2		–	30	60	50	–	–	–	–	50	2		–	2
R25-ME-PCC-208	Program Core Course- Lab	Material Testing and Characterization Lab	–	2	–	–	30	–	–	–	–	50	50	–	1	–	1
R25-ME-PCC-209	Program Core Course Lab / Multidisiplinary Course-Lab	GD&T and Geometric Modelling	–	2	–	–	30	–	–	25	25	–	50	–	1	–	1
R25-ME-ECEP-210	Comunity Engagement Project / Field Project	Comunity Engagement Project	–	4	–	–	60	–	–	50	–	–	50	–	2	–	2
Total			17	10	–	255	660	300	300	75	25	50	750	17	5	–	22

*Open Electives to be selected from the basket, offered at institute level.






Course Code	Course Type	Name of the Subject	Teaching Scheme					Examination Scheme and Marks						Credit			
			(Hrs./week)			SL	Total	CCE	ESE	TW	PR	OR	TOTAL	TH	PR	TUT	TOTAL
			TH	PR	TUT												
Semester- IV																	
R25-ME-PCC-211	Program Core course - 4	Manufacturing Processes-I	3	–	–	45	90	40	60	–	–	–	100	3	–	–	3
R25-ME-PCC-212	Program Core course - 5	Fluid Mechanics	3	–	–	45	90	40	60	–	–	–	100	3	–	–	3
R25-ME-PCC-213	Program Core course - 6	Applied Thermodynamics	3	–	–	45	90	40	60	–	–	–	100	3	–	–	3
R25-ME-OE-214	Open Elective - 2	Open Elective - 2	2	–	–	30	60	40	60	–	–	–	100	2	–	–	2
R25-ME-MDM-215	Multidisciplinary Course - 2	Mechatronics	2	–	–	30	60	40	60	–	–	–	100	2	–	–	2
R25-ME-VSEC-216	Vocational Skill Course	Workshop Practice	–	2	–	–	30	–	–	25	25	–	50	–	1	–	1
R25-ME-AEC-217	Ability Enhancement Course	Modern Indian Language and Technical Writing	1	2	–	15	60	–	–	50		–	50	1	1	–	2
R25-ME-HSSM-218	Entrepreneurship/Economics/ Management course	Entrepreneurship and Financial Management	2	–	–	30	60	50	–	–	–	–	50	2	–	–	2
R25-ME-PCC-219	Program Core Course- Lab	Mechatronics and IOT Lab	–	2	–	–	30	–	–		25	–	25	–	1	–	1
R25-ME-PCC-220	Program Core Course Lab	Thermo-Fluid Lab	–	2	–	–	30	–	–	25		–	25	–	1	–	1
R25-ME-VEC-221	Value Education Course	Green Technologies and Sustainable Development	2	–	–	30	60	50	–	–	–	–	50	2		–	2
Total			18	8	–	270	660	300	300	100	50	–	750	18	4	–	22

Approved by: Chairman, Academic Council xi



AMRUTVAHINI COLLEGE OF ENGINEERING, SANGAMNER
Department of Mechanical Engineering
S. Y. B Tech Syllabus Design Team

Sr. No.	Name of the course	Course Code	Syllabus Design Teams
Semester - III			
1	Solid Mechanics	R25-ME-PCC-201	Prof. V.M. Mhaske – Dr. Y.R. Gujnal – Dr. B.R. Varpe –
2	Engineering Thermodynamics	R25-ME-PCC-202	Prof. D.M. Nibe – Prof. R.R. Vilhekar – Prof. Y.J. Wagh – Prof. S.K. Amrutkar –
3	Engineering Materials & Metallurgy	R25-ME-PCC-203	Dr. K.D. Dagale – Prof. G.B. Jambukar – Prof. G.S. Pendbhaje –
4	Computational and Statistical Methods	R25-ME-MDM-204	Prof. R. D. Kandekar – Dr. P.N. Nagare – Dr. M.B. Shirke – Dr. K.B. Deshmukh – Dr. S.T. Gadakh –
5	Principles and Practices of Management	R25-ME-OEC-205(A)	Prof. K.K. Dighe – Dr. B.G. Shinde – Dr. M.S. Harne – Dr. D.S. Bajaj –
6	Entrepreneurial Thinking and Innovation	R25-ME-HSSM-206	Dr. E.T. Bayas – Dr. D.S. Bajaj – Dr. M.S. Harne – Dr. S.T. Gadakh –
7	Professional Ethics and Human Values	R25-ME-VEC-207	Prof. V.M. Mhaske – Prof. K.K. Dighe – Dr. K.B. Deshmukh – Prof. S.K. Amrutkar –
8	Material Testing and Characterization Lab	R25-ME-PCC-208	Dr. K.D. Dagale – Prof. G.B. Jambukar – Prof. G.S. Pendbhaje –
9	GD&T and Geometric Modelling Lab	R25-ME-PCC-209	Prof. A.V. Deokar – Prof. S.C. Fargade – Dr. B.G. Shinde – Dr. M.B. Shirke –



Sr. No.	Name of the course	Course Code	Syllabus Design Teams
10	Community Engagement Project	R25-ME-CEP-210	Dr. B.G. Shinde – <i>BG Shinde</i> Prof. S.P. Thorat – <i>SP Thorat</i> Prof. P.N. Gunjal – <i>PN Gunjal</i> Dr. S.D. Galande – <i>SD Galande</i>

Sr. No.	Name of the course	Course Code	Syllabus Design Teams
Semester - IV			
1	Fluid Mechanics	R25-ME-PCC-211	Prof. B.K. Varpe – <i>BK Varpe</i> Dr. K.B. Deshmukh – <i>KB Deshmukh</i> Prof. Y.J. Wagh – <i>YJ Wagh</i>
2	Manufacturing Processes-I	R25-ME-PCC-212	Dr. K.D. Dagale – <i>KD Dagale</i> Prof. O.U. Raktate – <i>OR Raktate</i> Dr. A.B. Aher – <i>AB Aher</i> Prof. G.S. Pendbhaje – <i>GS Pendbhaje</i>
3	Applied Thermodynamics	R25-ME-PCC-213	Prof. D.M. Nibe – <i>DM Nibe</i> Prof. Y.J. Wagh – <i>YJ Wagh</i> Prof. S.K. Amrutkar – <i>SK Amrutkar</i> Prof. R.R. Vilhekar – <i>RR Vilhekar</i> Dr. B.R. Varpe – <i>BR Varpe</i>
4	Mechatronics	R25-ME-MDM-214	Dr. S.D. Galande – <i>SD Galande</i> Dr. M.B. Shirke – <i>MB Shirke</i> Prof. K.S. Bhagwat – <i>KS Bhagwat</i> Prof. P.N. Gunjal – <i>PN Gunjal</i>
5	Agricultural Implements and Mechanization	R25-ME-OEC-215	Prof. O.U. Raktate – <i>OR Raktate</i> Dr. P.N. Nagare – <i>PN Nagare</i> Dr. S.T. Gadakh – <i>ST Gadakh</i> Prof. G.S. Pendbhaje – <i>GS Pendbhaje</i>
6	Workshop Practice	R25-ME-VSC-216	Prof. O.U. Raktate – <i>OR Raktate</i> Dr. K.D. Dagale – <i>KD Dagale</i> Dr. A.B. Aher – <i>AB Aher</i> Prof. G.S. Pendbhaje – <i>GS Pendbhaje</i>
7	Modern Indian Language and Technical Writing	R25-ME-AEC-217	Prof. G.B. Jambekar – <i>GB Jambekar</i> Dr. S.T. Gadakh – <i>ST Gadakh</i> Prof. V.M. Mhaske – <i>VM Mhaske</i> Prof. K.K. Dighe – <i>KK Dighe</i>
8	Entrepreneurship and Financial Management	R25-ME-EEM-218	Dr. E.T. Bayas – <i>ET Bayas</i> Dr. D.S. Bajaj – <i>DS Bajaj</i> Dr. M.S. Harné – <i>MS Harné</i> Dr. B.G. Shinde – <i>BG Shinde</i>

Amrutvahini

R. Gunjale



Sr. No.	Name of the course	Course Code	Syllabus Design Teams
9	Mechatronics and IOT Lab	R25-ME-PCC-219	Dr. S.D. Galande – Dr. B. G. Shinde – Dr. M.B. Shirke – Prof. K.S. Bhagwat – Prof. P.N. Gunjal –
10	Thermo-Fluid Lab	R25-ME-PCC-220	Prof. D.M. Nibe – Prof. Y.J. Wagh – Prof. S.K. Amrutkar – Prof. R.R. Vilhekar – Prof. B.K. Varpe – Dr. B.R. Varpe – Dr. K.B. Deshmukh –
11	Green Technologies and Sustainable Development	R25-ME-VEC-221	Prof. S.K. Amrutkar – Prof. Y.J. Wagh – Prof. P.S. Shivsharan – Prof. K.S. Bhagwat – Prof. A.S. Shinde –

Dr. V. D. Wakchaure
Chairman, Board of Studies, Mechanical Engg.

Chairman

BoS, Mechanical Engineering
Amrutvahini College of Engineering, Amrutnagar
Sangamner-422608

08/09/26

Dr. P. R. Baviskar
Chairman, Academic Council



SEMESTER - III

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Program:		S. Y. B. Tech (Mechanical Engineering)			Semester:		III	
Course:		SOLID MECHANICS			Course Code:		R25-ME-PCC 201	
Teaching Scheme				Examination Scheme				
Lecture	Practical	Tutorial	Credit	CCE	ESE	TW	PR	
03	--		03	40	60	--	--	
Course Description and Relevance: Course Solid Mechanics is fundamental core subject in Mechanical engineering, it explains how materials deform under applied loads and temperature changes through the study of stress and strain. Important concepts in this field include Hooke’s Law, bending stress in beams, torsion in shafts, beam deflection, and buckling of columns. Additionally, it supports optimization by reducing unnecessary weight and material usage, ensuring that components are neither over designed nor unsafe, thereby improving both performance and economy. Solid Mechanics enabling the design of safe, durable, and efficient structures and machinery by analyzing how materials deform, bend, or break under loads. It provides essential principles and theory for stress analysis, material selection, and failure prevention in almost everything from small machine components to aerospace structures.								
Prerequisite: 1. Engineering Mechanics - Force, equilibrium, free body diagram, moments 2. Physics – Equilibrium of force, motion, elasticity basic concepts 3. Mathematics - algebra, trigonometry, calculus basic differential equations 4. Material Science - basic knowledge of materials and their properties								
Bridge Content: Mechanical properties of Materials, Centroid, Center of gravity, Moment of Inertia								
Course Objectives: 1. To acquire basic knowledge of stress, strain due to various types of loading. 2. To draw Shear Force and Bending Moment Diagram for a loading beam. 3. To determine Bending and Shear stress in beam. 4. To determine the Torsional shear stress in shaft and Buckling load for the column. 5. To apply the concept of Principal Stresses to practical problems and Theories of elastic Failure.								
Course Outcomes: After learning the course, students will be able to								
CO	Course Outcome						Bloom’s Level	
CO1	DEFINE various types of stresses and strain developed on determinate and indeterminate members.						2	
CO2	DRAW Shear force and bending moment diagram for various types of beams and supports.						2	
CO3	COMPUTE the bending stresses and shear stresses on a beam.						2	
CO4	DETERMINE torsional shear stress in shaft and buckling load on the column.						2	
CO5	APPLY the concept of principal stresses and theories of failure to determine stresses on a 2-D element						3	
Course Content								
Unit 1	Simple Stress & Strain				10 Hrs.	COs Mapped CO1		



Introduction to types of loads (Static, Dynamic & Impact Loading) and various types of stresses with applications, Stress-strain diagram for ductile and brittle materials, Hooke's law, Poisson's ratio, Modulus of Elasticity, Modulus of Rigidity, Bulk Modulus. Interrelation between elastic constants, factor of safety. Stresses and strains in determinate and indeterminate beam, homogeneous and composite bars under concentrated loads, Thermal stresses in simple and composite members

Unit 2	Shear Force & Bending Moment Diagrams	8 Hrs.	COs Mapped CO2
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Introduction to SFD, BMD with application, SFD & BMD for statically determinate beam due to concentrated load, uniformly distributed load, uniformly varying load, couple and combined loading Relationship between rate of loading, shear force and bending moment, Concept of zero shear force, Maximum bending moment, point of contra-flexure.			
Unit 3	Bending & Shear Stresses in Beam	8 Hrs.	COs Mapped CO3
Bending Stress in a Beam: Introduction to bending stress on a beam with application, Theory of Simple bending, assumptions in pure bending, derivation of flexural formula, Moment of inertia of common cross section (Circular, Hollow circular, Rectangular, I & T), Bending stress distribution along the same cross-section Shear Stress in a Beam: Introduction to transverse shear stress on a beam with application, shear stress distribution diagram along the Circular, Hollow circular, Rectangular, I & T cross-section.			
Exemplars / Practical Applications and usage: Bending and shear stress analysis is widely used in mechanical engineering for designing machine components such as machine frames, crane hooks, chassis, levers, gears. The theory of simple bending and flexural formula help determine the strength and stiffness of beams under loading conditions various examples of club activity. Moment of inertia of sections like circular, rectangular, I, and T sections is important for selecting suitable beam shapes for mechanical components. Shear stress distribution analysis helps identify critical regions subjected to transverse loads and prevents structural failure. These concepts are essential in machine design, automotive engineering, manufacturing systems, and heavy mechanical structures.			
Unit 4	Torsion & Buckling of Column	8 Hrs.	COs Mapped CO4
Torsion of circular shafts: Introduction to torsion on a shaft with application, Basic torsion formulae and assumption in torsion theory, Torsion in stepped and composite shafts, Torque transmission on strength and rigidity basis, Torsional Resilience Buckling of columns: Introduction to buckling of column with its application, Different column conditions and critical, safe load determination by Euler's theory. Limitations of Euler's Theory. Rankine's theory and formula (theoretical only)			
Exemplars / Practical Applications and usage: Torsion theory is used in the design of rotating machine elements such as transmission shafts, turbines, and propeller shafts to safely transmit torque and power. Concepts like stepped and composite shafts, torsional rigidity, and torsional resilience help in improving strength and energy absorption capacity. Buckling of columns is important in the design of structural members such as building columns, bridge supports, and machine frames subjected to compressive loads. Euler's theory is used to determine the critical buckling load and safe load for columns under different end conditions. These concepts are widely applied in mechanical, civil, and structural engineering for safe and efficient design.			
Unit 5	Principal Stresses & Theories of Elastic Failure	10 Hrs.	COs Mapped CO5
Principal Stresses: Introduction to principal stresses with application, normal and shear stresses on any oblique Plane, Principal Stresses and location of principal planes (Analytical method and Mohr's Circle), Stresses due to combined Normal and Shear stresses Theories of Elastic failure: Introduction to theories of failure with application, Maximum principal stress theory, Maximum shear stress theory, Maximum distortion energy theory, Maximum principal strain theory, Maximum strain energy theory.			
Exemplars / Practical Applications and usage: Principal stresses and failure theories are widely used in the design and analysis of machine and structural components such as shafts, pressure vessels, bridges, aircraft structures, and gears. Mohr's Circle helps determine principal stresses, maximum shear stresses, and the orientation of principal planes. Stress analysis is important for components subjected to combined loading (bending, torsion, and axial loads). Failure theories like Rankine, Tresca, and Von Mises are used to predict failure in brittle and ductile materials. These			



concepts are extensively applied in mechanical, civil, aerospace, and automotive engineering for safe and economical design. Modern software such as ANSYS and FEA tools also use these theories for stress analysis and optimization.

Comprehensive Continuous Evaluation (CCE) components for the course:

1. **Class Tests / Unit Tests I (16M):**
Numerical problems, derivations, theory questions on stress, strain, SFD/BMD, torsion, buckling, and failure theories
2. **Assignments & Tutorials (16M):**
Problem-solving assignments, analytical exercises, derivations, Mohr's Circle, beam analysis, and design-based questions. Short objective tests covering formulas, concepts, assumptions, and applications.
3. **Case study/ Mini projects (08M):**
Case study on design activities done by Club students or real-world problems, four students will take one case study. Mini project on

Textbooks:

1. R.K. Rajput, Strength of Materials - Published by S. Chand Publishing
2. R.S. Khurmi, Strength of Materials - Published by S. Chand Publishing
3. R.K. Bansal, Strength of Materials - Published by Laxmi Publications
4. S. Ramamrutham, Strength of Materials - Published by Dhanpat Rai Publications

Reference Books:

1. Mechanics of Materials by Beer and Johnston — Published by McGraw-Hill Education
2. Mechanics of Materials by Gere and Timoshenko — Published by Cengage Learning

MOOCs Links and additional reading material:

<http://www.sanfoundry.com/1000-strength-materials-questions-answers/> (MCQ On Material)
<https://www.indiabix.com/mechanical-engineering/strength-of-materials/> (MCQ On all units)
<https://testbook.com/objective-questions/mcq-on-strength-of-materials--5eea6a0b39140f30f369de8b>
 (MCQ On all units)
<https://www.examveda.com/mechanical-engineering/practice-mcq-question-on-strength-of-materials-in-me/> (MCQ On all units GATE based)

CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	2	-	-	-	2	-	3	-	-	-	3	1	1
CO2	-	2	-	-	-	2	1	3	1	-	-	3	2	1
CO3	-	1	-	-	-	3	-	3	3	2	-	3	2	2
CO4	-	2	1	-	-	3	3	2	2	2	-	3	2	3
CO5	-	1	1	-	-	3	3	3	2	2	1	3	3	3
Avg.	1	1.6	1	-	-	2.6	2.3	2.8	2	2	1	3	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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Unit wise Weightage:

Exam	Unit1	Unit2	Unit3	Unit4	Unit5
CCE					
CT1	8	8			
A & T			8	8	
CS/MP					8
ESE	12	12	12	12	12
Total	20	20	20	20	20

Assessment Pattern

BT Level	CCE					ESE				
	CT1		A & T		CS & MP					
CO	CO1	CO2	CO3	CO4	CO5	CO1	CO2	CO3	CO4	CO5
L1										
L2	8	8	8	8		06	06	06	06	
L3					08	06	06	06	06	12
L4										
L5										
L6										

This course serves as a prerequisite for / maps with the following future courses:
Design of Machine Elements, Design of Transmission system, Mechanical Vibration, Ansys, Matlab software etc.

Job Mapping:

Job opportunities that one can get after learning this course:
Design engineering, Research and Development, Engineering Departments.

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Program:	S. Y. B. Tech (Mechanical Engineering)			Semester:	III		
Course:	Engineering Thermodynamics			Course Code:	R25-ME-PCC-202		
Teaching Scheme				Examination Scheme			
Lecture	Practical	Tutorial	Credit	CCE	ESE	TW	PR
03	--		3	40	60	--	--
Course Description and Relevance: Mechanical Engineering broadly has four sub-streams, i.e. Thermal and Fluids, Mechanisms and Design engineering, Materials and Manufacturing, Computational Techniques. Engineering Thermodynamics is the first course on Thermal Science and Engineering. It studies various energy interactions notably heat and work transfer. It is based on certain laws of nature which are never seen to be violated. Although, Thermodynamics lies at the core of thermal and fluid engineering, it also helps in understanding many concepts and courses from other sub-streams. Engineering Thermodynamics is a foundational subject for Mechanical Engineering because it explains how energy is converted between heat and work in real systems like engines, turbines, compressors, and power plants. It provides the scientific basis for designing and analyzing thermal systems used in automotive, aerospace, HVAC, and power generation industries. The concepts of laws of thermodynamics, entropy, properties of pure substances, and cycles are essential for understanding efficiency, performance, and energy losses in mechanical systems. This subject also builds the groundwork for advanced courses such as Heat Transfer, IC Engines, Refrigeration and Air Conditioning, and Power Plant Engineering.							
Prerequisite: 1. Higher Secondary Science Courses 2. Engineering Sciences 3. Engineering Mathematics–I and II							
Bridge Content: 1. Conceptual physics refresh 2. Work and energy: Mechanical work, internal energy, potential and kinetic energy 3. Basic gas ideas: Mole, pressure, volume, temperature, and simple gas behaviour 4. Algebra and units: Rearranging equations, handling ratios, and being careful with units. 5. Basic calculus intuition: Meaning of slope and area (e.g., area under a curve as work in a P–V diagram) 6. Graph reading: Comfort with interpreting and sketching simple plots like P–V and T–S qualitatively.							
Course Objectives: 1. To introduce the fundamental concepts of thermodynamics. 2. To understand the first laws of thermodynamics and its applications. 3. To understand the second law of thermodynamics and the concept of entropy. 4. To interpret the behavior of a pure substance 5. To study steam generators and vapour power cycles.							
Course Outcomes: After learning the course, students will be able to							
CO	Course Outcome						Bloom's Level
CO1	DESCRIBE the basics of thermodynamics with heat and work interactions.						2
CO2	EXPLAIN the First Law of Thermodynamics for closed and open systems.						2
CO3	APPLY the second law of thermodynamics to steady flow and non-flow processes.						3
CO4	DESCRIBE the properties of pure substances and steam processes.						2
CO5	INTERPRET thermodynamic vapor power cycles such as the Carnot cycle and Rankine cycle and assess cycle performance.						2
Course Content							
Unit 1	Fundamentals of Thermodynamics and Ideal Gas Equations				7 Hrs.	COs Mapped CO1	



Fundamentals of Thermodynamics: Introduction, review of basic definitions, Zeroth law of thermodynamics, macro and microscopic approach, state, path, process and cycles, point function and path function, Quasi-static process, equilibrium, thermocouples: type, working principle and applications.

Ideal Gas Equations: Ideal gas definition, gas laws: Boyle's law, Charles's law, Avogadro's law, equation of state, Ideal gas constant and universal gas constant, ideal gas processes-on p-v and T-s diagrams, constant pressure, constant volume, isothermal, adiabatic, polytropic, throttling processes (open and closed systems), calculations of heat transfer, work done, internal energy (Numerical).

Exemplars / Practical applications and usage:

1. To study steam generators and vapour power cycles.
2. Power plants, automotive, aerospace engineering and HVAC systems.

Unit 2	First Law of Thermodynamics:	7 Hrs.	COs Mapped CO2
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Concept of heat and work, Sign convention and its conversion. First law of thermodynamics, Joules experiments, Equivalence of heat and work. Application of first law to flow and non-flow Processes and Cycles. Steady flow energy equation (SFEE), Applications of SFEE to devices such as nozzle, turbine, compressors, Boilers and heat exchangers; especially condensers and evaporators, PMM-I kind. (Numerical on SFEE).

Exemplars / Practical Applications and usage:

1. Power plants, automotive engineering and HVAC systems.
2. Process engineering, Thermal design of mechanical systems

Unit 3	Second Law of Thermodynamics and Entropy	7 Hrs.	COs Mapped CO3
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Second Law of Thermodynamics: Limitations of first law of thermodynamics, thermal reservoir, heat engine, refrigerator and heat pump: schematic representation, efficiency and coefficient of performance (COP), Kelvin-Planck & Clausius statement of the second law of thermodynamics; PMM-II kind, equivalence of the two statements (Numerical).

Entropy: Clausius inequality, concept of reversibility and irreversibility, entropy as a property, principle of increase of entropy, entropy changes for an open and closed system, change of entropy for an ideal gas (Numerical).

Exemplars/Practical Applications and usage:

1. Refrigeration and air conditioning, compressors. heat engine, heat pump.
2. Analysis of the efficiency of heat engines, helping engineers understand the limits of energy conversion, such as in the Carnot cycle.
3. Refrigeration Systems: Entropy helps assess the energy dissipation in refrigeration cycles, guiding the design of more efficient cooling systems.

Unit 4	Properties of the steam and Steam Processes	7 Hrs.	COs Mapped CO4
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Formation of steam, phase changes, properties of steam, use of steam tables, study of p-v, T-s and h-s plots (Mollier Chart) for steam, dryness fraction and its determination using combined separating and throttling calorimeter, change of properties, work transfer and heat transfer in non-flow and steady flow vapour processes.

Exemplars / Practical Applications and usage:

1. Essential in steam quality measurement for power generation industries.
2. Used in steam cycles and industrial boilers for energy optimization.

Unit 5	Steam Generators and Vapor Power Cycles	7 Hrs.	COs Mapped CO5
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Steam Generators ; Definition, classification, construction and working of fire tube and water tube boilers , boiler mounting and accessories(Location and function only), Boiler performance and heat balance sheet(Numericals)

Vapour Power Cycles: Carnot cycle, Rankine cycle, Effect of superheat and boiler pressure on the performance of Rankine cycle, efficiency, work ratio and specific steam consumption for Rankine cycle, Reheat and Regeneration



Exemplars / Practical Applications and usage:

1. Steam generators (boilers) produce steam for power plants, process industries, heating systems and ships.
2. Boiler efficiency and heat balance sheets help identify losses and plan energy-saving measures.
3. Rankine and related vapour power cycles are the basic models of steam power plants (coal, nuclear, biomass).
4. Superheat, higher boiler pressure, reheats and regeneration are used in modern plants to improve efficiency and reduce fuel consumption and emissions.

Comprehensive Continuous Evaluation (CCE) components for the course:

1. Class Tests / Unit Tests:

- i. Descriptive type of class test on unit 1 and unit 2.

2. Field Assignment (Case Study):

Following are few examples (Unit 3)

- i. Cooling of tea experiment
- ii. Melting of ice and entropy increase
- iii. Human body as a heat engine
- iv. Refrigerator performance analysis (COP Experiment)
- v. Refrigerator power consumption study

3. Quiz: (Unit 4)

Quizzes are one of the most effective direct assessment tools for measuring the attainment of Course Outcomes (COs) in Thermodynamics because they evaluate students' conceptual understanding, numerical problem-solving ability, and application skills in a structured and measurable manner.

4. Assignments: (Unit 3)

Theoretical assignments play an important role in achieving Course Outcomes (COs) in Engineering Thermodynamics because they help students develop conceptual understanding, analytical thinking, and problem-solving ability beyond classroom lectures.

5. Industrial Visit: (Unit 5)

An **industrial visit** is one of the best indirect learning methods for achieving Course Outcomes (COs) in Engineering Thermodynamics because students observe how thermodynamic principles are actually applied in real engineering systems. It connects classroom theory with industrial practice, improving conceptual understanding, analysis skills, and problem-solving ability.

Textbooks:

1. P. K. Nag, "Engineering Thermodynamics", Tata McGraw Hill Publications.
2. R. K. Rajput, "Engineering Thermodynamics", EVSS Thermo, Laxmi Publications.
3. P. L. Ballaney, "Thermal Engineering", Khanna Publishers.
4. C.P. Arora, "Thermodynamics", Tata McGraw Hill.
5. Domkundwar, Kothandaraman and Domkundwar, "Thermal Engineering", Dhanpat Rai Publishers.
6. M. M. Rathore, "Thermal Engineering", Tata McGraw-Hill

Reference Books:

1. Rayner Joel, "Basic Engineering Thermodynamics", AWL-Addison Wesley
2. Cengel and Boles, "Thermodynamics an Engineering Approach", McGraw-Hill
3. G. Van Wylen, R. Sonntag "Fundamentals of Classical Thermodynamics", John Wiley & Sons
4. Holman J.P., "Thermodynamics", McGraw Hill
5. M. Achuthan, "Engineering Thermodynamics", PHI
6. Steam Tables/Data Book

MOOCs Links and additional reading material:

1. Basics: <https://archive.nptel.ac.in/content/storage2/courses/112103021/module1/lec1/2.html>
2. Gas laws: https://archive.nptel.ac.in/courses/127/106/127106135/?utm_source=chatgpt.com
3. SFEE: https://archive.nptel.ac.in/courses/114/105/114105029/?utm_source=chatgpt.com
4. First Law of Thermodynamics: <https://archive.nptel.ac.in/courses>
5. Second Law of Thermodynamics: <https://elearn.nptel.ac.in/shop/nptel/concepts-of-thermodynamics>

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6. Entropy: https://onlinecourses.nptel.ac.in/noc21_cy01/preview?utm_source=chatgpt.com
7. Properties of the steam: https://onlinecourses.nptel.ac.in/noc26_ae15/preview?utm_source=chatgpt.com
8. Vapour Processes: https://onlinecourses-archive.nptel.ac.in/noc18_me34/utm_source=chatgpt.com
9. Steam generators: https://onlinecourses.nptel.ac.in/noc25_me146/preview?utm_source=chatgpt.com
10. Vapour Power Cycles: https://archive.nptel.ac.in/courses/114/105/114105029/?utm_source=chatgpt.com
11. General: https://onlinecourses.nptel.ac.in/noc25_me146/preview?utm_source=chatgpt.com
12. General: https://onlinecourses.nptel.ac.in/noc25_me154/preview

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	1	-	-	1	1	2	1	1	2	-
CO2	3	3	2	2	2	-	-	1	1	2	1	1	3	-
CO3	3	3	2	1	2	-	1	1	1	2	1	1	3	-
CO4	3	3	2	2	2	-	1	1	1	2	1	1	3	-
CO5	3	3	3	2	3	1	1	1	1	2	2	1	2	1
Avg.	3	2.8	2	1.8	2	1	1	1	1	2	1.2	1	2.8	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Unit wise Weightage:

Exam	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
CCE					
CT1	08	08	-	-	-
Field Assignment(Case Study)	-	-	08	-	-
Quiz (MCQ)				08	-
Industrial Visit	-	-	-	-	08
ESE	12	12	12	12	12
Total	20	20	20	20	20

Assessment Pattern:

BT Level	CCE					ESE				
	CT1		Field Assignment	Quiz (MCQ)	Industrial Visit					
CO	CO1	CO2	CO3	CO4	CO5	CO1	CO2	CO3	CO4	CO5
L1	4									
L2	4	4		4	8	6	6	6	6	6
L3		4	8	4		6	6	6	6	6
L4										
L5										
L6										

This course serves as a prerequisite for / maps with the following future courses:

1. Applied Thermodynamics
2. Heat Transfer
3. Refrigeration and Air Conditioning
4. Power Plant Engineering
5. Internal Combustion Engines
6. Fluid Machinery
7. Energy Engineering

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8. Computational Fluid Dynamics (CFD)

Job Mapping:

Job opportunities that one can get after learning this course:

1. Thermal Audit Engineer
2. HVAC Engineer
3. Power Plant Engineer
4. Boiler Operation Engineer
5. Automobile Thermal Systems Engineer



Program:		S. Y. B. Tech			Semester:		III	
Course:		Engineering Materials & Metallurgy			Course Code:		R25-ME-PCC-203	
Teaching Scheme				Examination Scheme				
Lecture	Practical	Tutorial	Credit	CCE	ESE	TW	PR	
03Hrs/Week	--	--	3	40	60	--	--	
Course Description and Relevance: This course provides students with a strong foundation in engineering materials and metallurgy by introducing the relationship between structure, properties, processing, and performance of materials used in engineering applications. It covers crystal structures, defects, diffusion, deformation mechanisms, phase diagrams, metallurgical transformations, heat treatment, ferrous and non-ferrous materials, and advanced materials. The course enables learners to understand material selection, processing routes, microstructure-property relationships, and industrial applications in automotive, aerospace, manufacturing, and sustainable engineering sectors.								
Prerequisite: Basic concepts of Engineering Physics Fundamental understanding of Engineering Chemistry Introduction to Engineering Materials								
Bridge Content: Understanding the importance of material selection in engineering design and manufacturing.								
Course Objectives: 1. To understand structure–property–processing relationships of engineering materials 2. To study crystal structures, defects, diffusion and deformation mechanisms 3. To analyze phase diagrams and metallurgical transformations 4. To understand heat treatment and surface modification processes 5. To study ferrous and non-ferrous engineering materials used in industry 6. To evaluate advanced and sustainable materials for modern engineering applications								
Course Outcomes: After learning the course, students will be able to								
CO	Course Outcome						Bloom’s Level	
CO1	EXPLAIN crystal structures, defects, and properties of materials.						2	
CO2	EXPLAIN phase diagrams and metallurgical transformations.						2	
CO3	APPLY heat treatment processes to improve material performance.						3	
CO4	SELECT appropriate materials for engineering applications.						3	
CO5	DESCRIBE modern materials for advanced industrial applications.						2	
Course Content								
Unit 1	Crystal Structures, Material Properties and Testing					8 Hrs.	COs Mapped CO1	
Introduction to atomic bonding and its influence on material behavior, crystal systems including BCC, FCC, and HCP structures, coordination number and packing factor, Miller indices and crystallographic planes, point, line, and surface defects, diffusion mechanisms in solids, mechanical properties such as strength, ductility, hardness, toughness and resilience, elastic and plastic deformation, slip and twinning mechanisms, creep and fatigue failure, tensile testing, hardness testing methods, and basics of non-destructive testing..								
Exemplars / Practical Applications and usage: Material testing in industries, failure analysis and quality control.								
Unit 2	Phase Diagrams and Metallurgical Transformations					8 Hrs.	COs Mapped CO2	
Concept of phases and phase transformations, Gibbs phase rule and equilibrium systems, interpretation of cooling curves, unary and binary phase diagrams, lever rule, solidification behavior, eutectic, eutectoid,								



peritectic and peritectoid reactions, detailed study of Iron–Carbon equilibrium diagram, microstructure evolution in steels and cast irons, and prediction of phases for different carbon compositions.			
Exemplars / Practical Applications and usage: Alloy design, foundry and casting industries.			
Unit 3	Heat Treatment	8 Hrs.	COs Mapped CO3
Purpose and significance of heat treatment, Time Temperature Transformation (TTT) and Continuous Cooling Transformation (CCT) diagrams, annealing, normalizing, hardening, quenching and tempering processes, age hardening, case hardening methods such as carburizing and nitriding, flame and induction hardening, and surface modification techniques used for wear and corrosion resistance improvement.			
Exemplars / Practical Applications and usage: Gear and shaft manufacturing, tool and die industry			
Unit 4	Ferrous Materials	8 Hrs.	COs Mapped CO4
Classification of ferrous materials, role of alloying elements in steels, plain carbon steels and alloy steels, stainless steels, tool steels, high-speed steels, different types of cast irons including grey, white, malleable and ductile cast iron, heat-resistant ferrous materials, and correlation between microstructure, composition, heat treatment, and engineering properties.			
Exemplars / Practical Applications and usage: Automotive components, structural materials.			
Unit 5	Non-Ferrous and Advanced Materials	8 Hrs.	CO Mapped CO5
Non-ferrous engineering materials including aluminium, copper, magnesium, nickel, and titanium alloys, selection criteria for lightweight and corrosion-resistant applications, composites and hybrid composites, smart materials such as shape memory alloys and piezoelectric materials, biomaterials, nanomaterials, materials for additive manufacturing, and sustainable materials used in electric vehicles, aerospace, and advanced industrial systems.			
Exemplars / Practical Applications and usage: Lightweight structures, aerospace and modern manufacturing.			
Comprehensive Continuous Evaluation (CCE) components for the course:			
Course Projects (Mini/Micro Project): Mini project based on material selection, heat treatment, metallurgical analysis, failure analysis, or advanced engineering materials used in automotive, aerospace, energy, or manufacturing industries. Class Tests / Unit Tests: CT1: Unit I and Unit II Assignments: Material property analysis, phase diagram interpretation, heat treatment calculations, and case studies on engineering materials. Field Activity / Case Study: Industrial visit report on foundry, heat treatment shop, steel plant, or material testing laboratory; case study on material failure or industrial material selection. Quiz / Presentation: Technical quiz, seminar, or presentation on ferrous and non-ferrous materials, composites, smart materials, additive manufacturing materials, or sustainable engineering materials.			
Textbooks:			
- William D. Callister, Materials Science and Engineering, Wiley Publications. V. D. Kodgire, Material Science and Metallurgy for Engineers, Everest Publishing House.			



3. Sidney H. Avner, Introduction to Physical Metallurgy, McGraw Hill Publications.
4. V. Raghavan, Materials Science and Engineering, Prentice Hall of India Publications.
5. R. K. Rajput, Engineering Materials and Metallurgy, S. Chand Publications.
6. O. P. Khanna, Material Science and Metallurgy, Dhanpat Rai Publications.
7. R. A. Higgins, Engineering Metallurgy, CBS Publishers.

Reference Books:

1. V. Raghavan, Materials Science and Engineering, Prentice Hall of India Publications.
2. S. H. Avner, Introduction to Physical Metallurgy, McGraw Hill Publications.
3. ASM International, ASM Handbook – Properties and Selection of Materials, ASM International Publications.
4. William D. Callister and David G. Rethwisch, Materials Science and Engineering: An Introduction, Wiley Publications.
5. R. A. Higgins, Engineering Metallurgy, CBS Publishers.
6. O. P. Khanna, Material Science and Metallurgy, Dhanpat Rai Publications.

MOOCs Links and additional reading material:

1. <https://www.youtube.com/watch?v=E6oCdckcwYQ>
2. <https://www.youtube.com/watch?v=5vaYfd0fekI>
3. <https://www.youtube.com/watch?v=3IQz9LAPuIA>
4. <https://www.youtube.com/watch?v=He4bek-XcLc>
5. <https://www.youtube.com/watch?v=-SA55zz4Lno&list=PLC3F0FC4543ADAC48>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	1	1	-	-	-	-	-	-	2	1	-
CO2	3	3	1	2	1	-	-	-	-	-	-	3	1	-
CO3	3	2	2	2	2	-	-	-	-	-	-	3	2	1
CO4	3	3	2	1	2	-	1	-	-	-	-	3	2	-
CO5	2	3	2	2	2	1	2	1	-	-	-	2	3	2
Avg.	2.8	2.6	1.4	1.6	1.6	0.2	0.6	0.2	0	0	0	2.6	1.8	0.6

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Unit wise Weightage:

Exam	Unit1	Unit2	Unit3	Unit4	Unit5
CT1	CO-1&2		-	-	-
CCE Assessment by Teacher	8 Unit Test	8 Unit Test	8 Quiz	8 Presentation	8 Mini Project
ESE	12	12	12	12	12
Total	20	20	20	20	20

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Assessment Pattern

BT Level	CCE						ESE				
	CT1	CCE2	CCE3	CCE4							
CO	CO 1&2						CO1	CO2	CO3	CO4	CO5
L1	-	-	-	-			-	-	-	-	-
L2	8	4	-	-			6	6	6	6	6
L3	8	4	-	8			6	6	6	6	6
L4	-	-	8	-			-	-	-	-	-
L5	-	-	-	-			-	-	-	-	-
L6	-	-	-	-			-	-	-	-	-

This course serves as a prerequisite for / maps with the following future courses:

1. Manufacturing Processes
2. Heat Transfer and Thermal Engineering
3. Machine Design
4. Advanced Manufacturing Processes
5. Additive Manufacturing

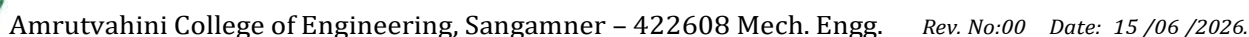
Job Mapping:

Job opportunities that one can get after learning this course:

1. Materials Engineer
2. Production Engineer
3. Material Testing Laboratory Engineer.

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Course Description

Course Relevance

Prerequisite:

- Differential and Integral Calculus
- Basic Algebra and Trigonometry
- Elementary Probability concepts

To prepare students for this course, the following revision topics are recommended:

- Strengthen basic mathematical foundations required for engineering mathematics.
- Refresh key concepts of algebra, calculus, and probability.
- Build confidence for advanced topics like transforms, statistics, and numerical methods.
- Ensure uniform understanding among students from different academic backgrounds.

The objectives of this course are to:

- Use numerical methods for solving algebraic and differential equations.
- Solve engineering problems using Laplace and Fourier transforms.
- Apply vector calculus and complex number concepts in engineering applications.
- Analyse data using statistical methods.
- Understand and apply probability theory in engineering problems.

CO	Course Outcome	Bloom's Level
CO1	Solve linear equations and differential equations using numerical techniques such as Gauss elimination, Runge-Kutta, and iterative methods.	3
CO2	Apply Laplace and Fourier transforms to solve differential equations and analyse engineering systems in time and frequency domains.	3
CO3	Apply vector operations, differential operators, and complex number theory to	3



	solve problems in mechanics, electromagnetics, and fluid flow.	
CO4	Analyse and interpret data using statistical methods such as correlation, regression, and measures of central tendency and dispersion.	3
CO5	Apply probability concepts, random variables, and standard distributions to solve engineering problems involving uncertainty and reliability.	3

Course Content			
Unit 1	Numerical Methods	8 Hrs.	CO1
Solution of simultaneous linear equations by the Gauss elimination method with partial pivoting, the Gauss-Seidel method with the successive over-relaxation (SOR), and the tri-diagonal matrix algorithm. Numerical solution of ordinary differential equations using Euler's method, Runge-Kutta method, and engineering applications of numerical methods. Numerical solution of partial differential equations using the finite difference approximation method (Laplace equations, one-dimensional heat or diffusion equation / parabolic PDEs, hyperbolic equations (wave-like PDEs))			
Exemplars / Practical Applications, Usage: Numerical methods are used in Finite Element Analysis (FEA), Computational Fluid Dynamics (CFD), Kinematics & Dynamics and Vibrational Analysis.			
Unit 2	Laplace and Fourier Transform	8 Hrs.	CO2
Definition of Laplace transform, properties of Laplace transform, inverse Laplace transform, Laplace transform of standard functions, applications to linear differential equations, transfer function, Fourier series, Fourier transform, properties of Fourier transform, vibration and frequency response analysis.			
Exemplars / Practical Applications, Usage: The Laplace transform is an important tool for modelling dynamic systems, such as vibrating machinery or vehicle suspensions and control systems. The Fast Fourier Transform tool is utilised for predictive maintenance of rotary machines, structural dynamics, modal analysis, acoustics and noise control.			
Unit 3	Vector Calculus and Complex	8 Hrs.	CO3
Vector algebra, dot product and cross product, gradient, divergence and curl, vector differentiation, complex numbers, polar form of complex numbers, De Moivre's theorem, operations on complex numbers, applications in mechanics and fluid flow.			
Exemplars / Practical Applications, Usage: Vector Calculus and Complex Algebra are foundational pillars in mechanical engineering, providing the mathematical language required to model and solve real-world physical systems. They enable engineers to analyse forces, predict fluid and heat flow, and design robust dynamic and control systems.			
Unit 4	Algebra, Statistics & Data Analysis	8 Hrs.	CO4
Measures of central tendency (mean, median, mode), measures of dispersion (variance, standard deviation), correlation coefficient, linear regression, regression analysis for engineering data, curve fitting using the least squares method, and experimental data analysis.			
Exemplars / Practical Applications, Usage: Statistics is the backbone of mechanical engineering, used in the fields of Quality Control & Manufacturing, Reliability & Risk Assessment, Design of Experiments (DOE), Material Selection & Geometric Tolerances, and Regression & Predictive Modelling.			
Unit 5	Probability Theory	8 Hrs.	CO5
Random experiments and events, axioms of probability, conditional probability and Bayes' theorem, random variables (discrete and continuous), probability distributions (Binomial, Poisson, Normal), expectation, variance,			



standard deviation, reliability concepts and engineering applications.

Exemplars / Practical Applications, Usage:

Probability provides a mathematical framework for mechanical engineers to work in areas like Reliability Engineering & Risk Assessment, Fatigue Life Prediction, Six Sigma & Quality Control, Design Optimisation (FORM/SORM), Vibration & Acoustics, and Fluid Dynamics & Heat Transfer.

Comprehensive Continuous Evaluation (CCE) components for the course:

1. Unit test on Unit 1 and Unit 2
2. Assignments on Unit 3
3. Application based case studies on Unit 4 and Unit 5

Textbooks:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.
2. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India.
3. R.K. Jain & S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House.

Reference Books:

1. Dennis G. Zill, Advanced Engineering Mathematics, Jones & Bartlett.
2. Peter V. O'Neil, Advanced Engineering Mathematics, Cengage Learning
3. H. K. Dass, Engineering Mathematics, S. Chand Publications.
4. E. Kreyszig, Advanced Engineering Mathematics, Wiley (International Edition).

MOOCs Links and additional reading material:

1. <https://nptel.ac.in/courses/127106019>
2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc20_ma43
3. <https://nptel.ac.in/courses/111101164>
4. https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ma27
5. https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ma39
6. https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ma74

Strength of CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	-	-	-	-	2	2	1	-	2
CO2	3	3	-	-	-	-	2	2	1	-	2
CO3	2	2	-	-	-	-	2	2	1	-	2
CO4	3	3	-	-	-	-	2	2	1	-	2
CO5	3	3	-	-	-	-	2	2	1	-	2
Avg.	2.60	2.60	-	-	-	-	2.00	2.00	1.00	-	2.00

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Table:

EXAM	Assessment tool	CO1	CO2	CO3	CO4	CO5
Knowledge and Attitude Profile (WK)		----	----	----	----	----
CCE	CT1	08	08	----	----	----
	CT2	----	----	----	----	----
	Assignments	----	----	08	----	----

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	Course Project	----	----	----	----	----
	Field Activity / Case Study	----	----	----	08	08
	Quiz / Presentation etc.	----	----	----	----	---
ESE	60	12	12	12	12	12
Total	100	20	20	20	20	20

Unit wise Weightage:

Exam	Unit1	Unit2	Unit3	Unit4	Unit5
CT1	8	8	---	---	---
Assignment	---	---	08	---	---
Field Activity / Case Study	---	---	---	08	08
ESE	12	12	12	12	12
Total	20	20	20	20	20

This course serves as a prerequisite for / maps with the following future courses:

1. Modelling and simulation
2. Real-world data analysis
3. Mechanical system design
4. Advanced software tools like MATLAB, ANSYS, CFD, and ML algorithms
5. GATE Exam/ CAT Exam /Aptitude Tests

Job Mapping:

Job opportunities that one can get after learning this course:

1. Creating mathematical software, building physical/financial simulations, and developing machine learning algorithms.
2. System modelling and Digital signal processing.
3. AI, Quantitative finance, and Quantum computing.
4. Data scientist, Data / Business Analyst, and Financial Risk Analyst.
5. Quantitative Analysts and Operations Research Analysts.



Program:	S. Y. B. Tech (Mechanical Engineering)			Semester:	III		
Course:	Entrepreneurial Thinking and Innovation			Course Code:	R25 – ME – HSSM – 206		
Teaching Scheme				Examination Scheme			
Lecture	Practical	Tutorial	Credit	CCE	ESE	TW	PR
01	02	--	--	50	--	--	--
Course Description and Relevance: This course introduces students to the concepts of entrepreneurship, innovation, creativity, and startup development with emphasis on developing an entrepreneurial mindset among engineering students. The course covers opportunity identification, design thinking, business modeling, startup planning, innovation management, Intellectual Property Rights (IPR), and leadership skills required for transforming innovative ideas into viable business ventures. Through case studies, practical activities, and project-based learning, students gain exposure to real-world entrepreneurial practices and innovation-driven problem-solving approaches. The course is highly relevant for engineering students as it encourages independent thinking, creativity, leadership, teamwork, and decision-making skills essential for professional success. It helps students identify business opportunities related to engineering applications, understand startup ecosystems, and explore sustainable and technology-driven innovations. The course also creates awareness about government initiatives, funding support, and emerging entrepreneurial trends, thereby preparing students for startup creation, innovation management, and industry-oriented career opportunities.							
Prerequisite: Basic understanding of engineering concepts, creativity, problem-solving approaches, communication skills, teamwork, and awareness of innovation and business fundamentals.							
Bridge Content: Introduction to entrepreneurship and innovation concepts, basic business and management terminology, fundamentals of economics and marketing, overview of communication and teamwork skills, and awareness of creativity, problem-solving, and startup development approaches relevant to engineering applications.							
Course Objectives: 1. To UNDERSTAND the fundamentals of entrepreneurship, innovation, and startup ecosystems. 2. To UNDERSTAND opportunity identification, market needs, and design thinking approaches for problem-solving. 3. To UNDERSTAND business models, Lean Startup concepts, and startup development strategies. 4. To UNDERSTAND entrepreneurial planning, leadership, communication, and Intellectual Property Rights concepts.							
Course Outcomes: After learning the course, students will be able to							
CO	Course Outcome						Bloom’s Level
CO1	Explain the fundamentals of entrepreneurship, innovation, and startup ecosystems.						2
CO2	Apply design thinking approaches for identifying opportunities and solving problems.						3
CO3	Develop business models and startup strategies using Lean Startup concepts.						3
CO4	Understand entrepreneurial planning, leadership, communication, and Intellectual Property Rights concepts in startup development.						2
Course Content							
Unit 1	Foundations of Entrepreneurship and Entrepreneurial Mindset				8 Hrs.	COs Mapped CO1	
Meaning and importance of entrepreneurship , Role of entrepreneurs in economic development, Characteristics and competencies of successful entrepreneurs, Entrepreneurial mindset and growth mindset, Types of entrepreneurship: Technology entrepreneurship, Social entrepreneurship, Manufacturing entrepreneurship, Green entrepreneurship, Entrepreneurial opportunities in Mechanical Engineering, Startup ecosystem in India, Government initiatives: Startup India, Make in India, MSME schemes, Atal Innovation							



Mission.			
Exemplars / Practical Applications and usage: Study of successful Indian startups such as Ola, Zerodha, and Paytm; identification of entrepreneurial opportunities in mechanical engineering industries; analysis of Startup India, Make in India, and MSME support schemes; discussion on entrepreneurial mindset and innovation driven business models in manufacturing and technology sectors.			
Unit 2	Creativity, Design Thinking and Innovation	8 Hrs.	COs Mapped CO2
Creativity and innovation: concepts and differences, Barriers to creativity, Techniques for idea generation: Brainstorming, SCAMPER (substitute, combine, adapt, modify, put to another use, eliminate, and reverse), Mind mapping, TRIZ basics, Introduction to Design Thinking : Empathize, Define, Ideate, Prototype, Test, Innovation process and innovation management, Product innovation in mechanical systems, Sustainable and frugal innovation.			
Exemplars / Practical Applications and usage: Application of brainstorming and mind mapping techniques for idea generation; design thinking activities for solving real-world engineering problems; development of simple prototypes for innovative products; case studies on product innovation in mechanical systems and sustainable engineering solutions.			
Unit 3	Opportunity Identification and Business Modeling	8 Hrs.	COs Mapped CO3
Problem identification and opportunity recognition, Market need analysis, Customer discovery and customer pain points, Value proposition concept, Basics of market survey and validation, Business Model Canvas: Customer segments, Value proposition, Channels, Revenue streams, Key resources, Lean startup approach, Case studies of engineering startups.			
Exemplars / Practical Applications and usage: Preparation of Business Model Canvas for startup ideas; market survey and customer need analysis for engineering products; identification of customer pain points and value propositions; case studies of engineering startups using Lean Startup approaches and innovative business models.			
Unit 4	Innovation to Startup	8 Hrs.	COs Mapped CO4
Converting ideas into startups, Basics of prototype development, Intellectual Property Rights (IPR): Patents, Copyrights, Trademarks, Industrial design, and Technology commercialization, Pitching entrepreneurial ideas, Startup team formation and leadership, Ethics in entrepreneurship Case studies of successful Indian engineering entrepreneurs.			
Exemplars / Practical Applications and usage: Development of startup ideas into basic prototypes; preparation of startup pitch presentations and business proposals; study of patent, copyright, and trademark applications for innovative products; case studies of successful Indian engineering entrepreneurs and startup leadership practices.			
Comprehensive Continuous Evaluation (CCE) components for the course: Students shall form groups of four members each . Every group is required to perform any four activities from the below list.			
• Startup Idea Generation and Opportunity Identification Assignment. • Business Model Canvas Preparation. • Case Study Analysis of Successful Startups and Entrepreneurs. • Design Thinking Activity. • Group Discussion on Innovation and Emerging Startup Trends. • Preparation and Presentation of Business Plan & Pitch Deck. • Market Survey and Need Analysis Report. • Presentation on Startup Ecosystem, Funding or IPR. • Mini Project on Innovative Product or Service Development. • Prepare report on Industry Expert Interaction.			



- Incubation Center Visit Report.
- Team Activity on Prototype.

Textbooks:

1. Nigel Cross, Design Thinking: Understanding How Designers Think and Work, Berg Publishers, 2011.
2. Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, Harper Business, 2009.
3. S. S. Khanka, Entrepreneurship Development, S. Chand Publishing, 2022.
4. Poornima M. Charantimath, Entrepreneurship Development and Small Business Enterprises, Pearson Education India, 2018.
5. David H. Holt, Entrepreneurship: New Venture Creation, Prentice Hall India, 2016.
6. R. G. Desai, Innovation and Entrepreneurship, Himalaya Publishing House, 2020.
7. Norman M. Scarborough, Essentials of Entrepreneurship and Small Business Management, Pearson Education, 2017.

Reference Books:

1. Ranjan Nayar and Jaidip Subedi, Design Thinking for Visual Communication, Bloomsbury Publishing, 2021.
2. Don Norman, The Design of Everyday Things, Basic Books, 2013.
3. Bill Aulet, Disciplined Entrepreneurship: 24 Steps to a Successful Startup, Wiley, 2013.
4. Peter Thiel and Blake Masters, Zero to One, Crown Business, 2014.
5. Steve Blank and Bob Dorf, The Startup Owner's Manual, K&S Ranch Publishing, 2020.
6. Navi Radjou, Jaideep Prabhu, and Simone Ahuja, Jugaad Innovation, Jossey-Bass, 2012.
7. Rashmi Bansal, Stay Hungry Stay Foolish, CIIE/IIM Ahmedabad, 2008.
8. Rashmi Bansal, Connect the Dots, Westland Publications, 2012.
9. Peter F. Drucker, Innovation and Entrepreneurship, Harper Business, 2006.
10. Rohit Prasad, Startup Sutra, Hachette India, 2013.
11. Ronnie Screwvala, Dream With Your Eyes Open, Rupa Publications, 2015.

MOOCs Links and additional reading material:

1. Entrepreneurship Essentials (NPTEL – IIT Kharagpur) <https://nptel.ac.in/courses/110105067>
2. Entrepreneurship and Innovation (NPTEL – IIT Roorkee) <https://onlinecourses.nptel.ac.in>
3. Design Thinking – A Primer, NPTEL – IIT Madras, <https://nptel.ac.in/courses/109106124>

CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	–	–	–	2	1	3	2	2	2	1	–	2
CO2	2	3	3	2	1	1	2	1	2	2	2	2	2	2
CO3	2	3	3	2	1	1	1	1	2	2	3	2	2	3
CO4	1	2	2	1	–	2	2	3	3	3	2	1	1	2
CO5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avg.	1.75	2.50	2.00	1.25	0.50	1.50	1.50	2.00	2.25	2.25	2.25	1.50	1.25	2.25

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Unit wise Weightage:

Exam	Unit1	Unit2	Unit3	Unit4	-
CCE	12	13	13	12	-
ESE	-	-	-	-	-
Total	12	13	13	12	-

Amrutvahini

R. G. Desai



Assessment Pattern

BT Level	CCE						ESE				
	CCE1	CCE2	CCE3	CCE4							
CO	CO1	CO2	CO3	CO4			CO1	CO2	CO3	CO4	CO5
L1	-	-	-	-	-	-	-	-	-	-	-
L2	12	-	-	12	-	-	-	-	-	-	-
L3		13	13		-	-	-	-	-	-	-
L4	-	-	-	-	-	-	-	-	-	-	-
L5	-	-	-	-	-	-	-	-	-	-	-
L6	-	-	-	-	-	-	-	-	-	-	-
Total	12	13	13	12	-	-	-	-	-	-	-

This course serves as a prerequisite for / maps with the following future courses:
Engineering Economics and Financial Management

Job Mapping:

Job opportunities that one can get after learning this course:
Entrepreneur / Startup Founder, Incubation Program Associate.

(Signature)

(Signature)



Program:		S. Y. B. Tech (Mechanical Engineering)		Semester:		III	
Course:		Professional Ethics and Human Values		Course Code:		R25-ME-EVC-207	
Teaching Scheme				Examination Scheme			
Lecture	Practical	Tutorial	Credit	CCE	ESE	TW	OR
02	--		01	50	--	--	--
Course Description and Relevance: The course Professional Ethics and Human Values course is highly relevant for professional engineers as it promotes ethical decision-making, social responsibility, mutual respect, and value-based living. It focuses on developing a holistic understanding of life, human values, relationships, and ethical conduct among engineering students. It helps learners understand harmony within self, family, society, nature, and the entire existence through the process of self-exploration. It also guides students to balance technical competence with human values for sustainable development and professional excellence. The course supports the development of responsible individuals capable of contributing positively to society and the engineering profession.							
Prerequisite: Student Induction Program (SIP) (desirable)							
Bridge Content: <i>Yoga and Meditation Sessions:</i> Conducting yoga, mindfulness, and meditation practices for self-regulation, mental harmony, and stress management. <i>Group Discussion and Reflection Activities:</i> Reflection writing, value-based discussions, and case studies on ethical issues, relationships, happiness, and professional ethics. <i>Interaction with Social Reformers / Motivational Speakers:</i> Expert talks on human values, ethics, sustainable living, and social harmony to connect classroom learning with real-life experiences.							
Course Objectives: 1. To help students understand the importance of professional ethics, code of conduct, industrial safety, and responsible engineering practices in mechanical engineering. 2. To develop understanding about ASME ethics, ethical responsibilities, safety standards, and sustainable professional behaviour in engineering applications. 3. To facilitate understanding of harmony within self, family, and society through values such as trust, respect, cooperation, and mutual fulfilment. 4. To elaborate the interconnectedness, coexistence, and harmony present in nature and the entire existence for sustainable living. 5. To develop ethical decision-making ability and value-based professional conduct through right understanding and self-exploration.							
Course Outcomes: After successful completion of the course, learner will be able to:							
CO	Course Outcome						Bloom's Level
CO1	Apply universal human values and ethical principles in personal life, professional conduct, and engineering practices for sustainable and value-based development.						2
CO2	Interpret about ASME ethics, ethical responsibilities, safety standards, and sustainable professional behaviour in engineering applications						2
CO3	Understand the coexistence of self and body, distinguish their needs, and understand harmony within the human being.						2
CO4	Demonstrate understanding of values in human relationships and harmony in family and society for responsible social living.						2
CO5	Analyze interconnectedness, mutual fulfilment, and harmony among the different orders of nature and existence.						2



Course Content			
Unit 1	Fundamental Principles and Code of Ethics	6 Hrs.	COs Mapped CO1
Use knowledge and skill for the welfare of humanity. Be honest, impartial, and serve society responsibly. Improve professional competence continuously. Support engineering societies and professional development. Engineers should work only in fields where they are qualified through: Education, Training, Experience. Engineers must prioritize: Safety, Health, Welfare of the public, Environmental protection. Engineers should: Learn new technologies, Update technical knowledge, Attend training and workshops. Engineers must: Protect employer/client interests, Maintain confidentiality, Avoid conflicts of interest. Exemplars / Practical Applications and usage: A mechanical engineer designing a pressure vessel must ensure it meets safety standards to prevent accidents. A thermal engineer should not approve structural designs without proper expertise. Not sharing confidential machine design data with competitors.			
Unit 2	Importance of ASME Ethics in Mechanical Engineering, Industrial Safety	6 Hrs.	COs Mapped CO2
Ensures safe operation of: Boilers, Pressure vessels, Turbines, Manufacturing systems. Promotes: Reliable products, Standard manufacturing practices, Customer trust. Encourages: Energy conservation, Pollution reduction, Sustainable engineering. Ethical behaviour improves: Career growth, Industry credibility, Public confidence Applications in Mechanical Engineering Design Engineering: Following safety standards during machine design. Manufacturing: Maintaining quality and worker safety. Maintenance Engineering: Reporting faults honestly and preventing unsafe operations. Research and Development: Avoiding plagiarism and maintaining research integrity. Common Ethical Issues in Mechanical Engineering Ignoring safety standards to reduce cost, Using low-quality materials, Copying patented designs, Hiding manufacturing defects, Manipulating inspection reports, Environmental pollution from industries Exemplars / Practical Applications and usage: The American Society of Mechanical Engineers Code of Ethics helps mechanical engineers maintain safety, quality, honesty, and environmental responsibility. It ensures safe operation of boilers, pressure vessels, turbines, and manufacturing systems while promoting reliable products, standard practices, and customer trust. Ethical engineering also supports energy conservation, pollution reduction, sustainable development, career growth, industry credibility, and public confidence. In mechanical engineering, ethics are applied in design, manufacturing, maintenance, and research activities by following safety standards, maintaining product quality, reporting faults honestly, and avoiding plagiarism. Common ethical issues include ignoring safety standards, using low-quality materials, copying patented designs, hiding defects, manipulating inspection reports, and causing industrial pollution. Following ASME ethics helps engineers work responsibly and professionally.			
Unit 3	Harmony in Human Being, Family and Society	6 Hrs.	COs Mapped CO3
Harmony in the Human Being Understanding human being as the co-existence of Self (I) and Body. Distinguishing between needs of the Self (happiness, understanding) and Body (physical facilities). The body as an instrument of the Self Understanding harmony in the Self (inner balance, right understanding, happiness). Harmony between Self and Body (proper coordination and self-regulation). Program for ensuring self-regulation, health, and well-being Harmony in the Family Family as the basic unit of human interaction, Trust as the foundational value in relationships Respect as right evaluation of human beings, Other essential human values in relationships (affection, care,			



guidance, reverence, gratitude, love), Strengthening harmony and mutual understanding in family relationships Harmony in Society Understanding harmony in human-to-human relationships in society, Social systems based on mutual cooperation and coexistence, Vision for a universal human order (universal harmony and justice), Role of values in building peaceful and sustainable society			
Exemplars / Practical Applications and usage: The concepts of trust, respect, and right relationships help students develop healthy interactions within family, friends, workplace, and society. Understanding harmony in human-to-human relationships promotes cooperation, empathy, mutual understanding, and social responsibility. These values are useful in teamwork, leadership, conflict resolution, and professional ethics in engineering and organizational environments. The vision of a universal human order encourages responsible citizenship, social harmony, and sustainable community development. This unit helps learners build positive relationships and contribute effectively towards a peaceful and value-based society.			
Unit 4	Harmony in the Nature (Existence)	6 Hrs.	COs Mapped CO3, CO4
Understanding Harmony in the Nature Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature Realizing Existence as Co-existence at All Levels The Holistic Perception of Harmony in Existence Professional Ethics in the light of Right Understanding Strategies for Transition towards Value-based Life and Profession			
Exemplars / Practical Applications and usage: The concepts of harmony in nature and coexistence help students understand the interconnectedness among humans, animals, plants, and the environment. Awareness of mutual fulfilment and self-regulation in nature promotes environmental protection, sustainable resource utilization, and ecological balance. These concepts are useful in developing ethical and socially responsible engineering practices such as pollution control, energy conservation, and sustainable development. Understanding professional ethics in the light of right understanding supports responsible decision-making and commitment towards society and nature. This unit encourages students to adopt a value-based lifestyle and contribute towards a sustainable and harmonious world.			
Comprehensive Continuous Evaluation (CCE) components for the course:			
1. Course Projects (Mini/Micro Project): (10M) Students are encouraged to undertake mini or micro projects related to Universal Human Values that help them understand harmony within self, family, society, nature, and professional life. The objective of the project is to apply the concepts of self-exploration, ethical conduct, mutual respect, and social responsibility in real-life situations. The project may include activities such as case studies on ethical issues, community service, environmental awareness programs, reflective journals, surveys on social harmony, meditation/yoga practice analysis, or value-based awareness campaigns. Students may also explore the role of human values in engineering profession, sustainable development, workplace ethics, and responsible citizenship. The project can be presented in the form of reports, presentations, posters, videos, or field activity documentation.			
2. Class Tests / Unit Tests: (Base for Oral Examination) (10M) Class tests/unit tests conducted for: Unit III & IV: (10M)			
3. Assignments on Professional Ethics in Mechanical Engineering. (10M)			
4. Holistic and Experiential Assessment (Group Wise): (20M) 1. Reflective Writing / Self-Assessment Activities			



2. Group Discussion / Team Activities
3. Community Service / Social Activity Report
4. Nature Visit / Spiritual Visit Reflection Report
5. Role Play / Value-based Situation Analysis

Textbooks:

1. RR Gaur, R Asthana, GP Bagaria, A Foundation Course in Human Values and Professional Ethics, 3rd revised edition, UHV Publications, 2023, ISBN: 978-81-957703-7-3 (Printed Copy), 978-81- 957703-6-6 (e-book)
2. RR Gaur, R Asthana, GP Bagaria, Teacher's Manual for A Foundation Course in Human Values and Professional Ethics, 3rd revised edition, UHV Publications, 2023, ISBN: 978-81-957703-5-9 (Printed Copy), 978-81-957703-0-4 (e-Book).

Reference Books:

1. P. L. Dhar, R. R. Gaur (1990) Science and Humanism, Commonwealth Publishers.
2. A. Nagaraj (1999) Jeevan Vidya: Ek Parichaya, Jeevan Vidya Prakashan, Amarkantak.
3. B. P. Banerjee (2005) Foundations of Ethics and Management, Excel Books.
4. A. N. Tripathy (2003) Human Values, New Age International Publishers.
5. E. G. Seebauer & Robert L. Berry (2000) Fundamentals of Ethics for Scientists & Engineers, Oxford University Press.
6. B. L. Bajpai (2004) Indian Ethos and Modern Management, New Royal Book Co., Lucknow.
7. M. Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics and Human Values, Eastern Economy Edition, Prentice Hall of India Ltd.
8. M. K. Gandhi, "The Story of my Experiments with Truth", Discovery Publisher.

MOOCs Links and additional reading material:

1. Dr. Kumar Sambhav, Swayam Course on "Understanding Human Being Nature and Existence Comprehensively". https://onlinecourses.swayam2.ac.in/aic22_ge23/preview
2. Prof. A. K. Sharma. NPTEL Course on "Exploring Human Values: Visions of Happiness and Perfect Society" <https://nptel.ac.in/courses/109104068>
3. Learning Material channel helps teaching-learning resources material related on Human Values & Ethics, https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw

CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	-	-	-	-	2	-	3	-	-	-	-	3	2
CO2	2	2	-	-	-	3	2	3	-	-	-	1	3	2
CO3	-	-	-	-	-	2	-	3	3	2	-	-	3	2
CO4	-	2	-	-	-	3	3	2	-	-	-	-	3	2
Avg.	1.5	2	-	-	-	2.5	2.5	2.75	3	2	-		3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Unit wise Weightage:

Exam	Unit1	Unit2	Unit3	Unit4
MP	10			
CT1			5	5
Case Study		10		
Oral	2	3	7	8

(Signature)

(Signature)



Total	12	13	12	13
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Assessment Pattern

BT Level	CCE					ESE				
	MP	CT1		AS	Oral					
CO	CO1	CO3	CO4	CO2	CO	CO1	CO2	CO3	CO4	CO5
L1										
L2	10	05	05	10	20					
L3										
L4										
L5										
L6										

This course serves as a prerequisite for / maps with the following future courses:

- Industrial Management and Organizational Behaviour
- Entrepreneurship Development
- Project Management
- Environmental Engineering and Sustainability
- Quality Management Systems
- Industrial Safety and Engineering Practices
- Research Methodology and Innovation
- Internship, Seminar, and Project Work
- Corporate Training and Leadership Development Programs

Job Mapping:

The course Universal Human Values supports the development of professional ethics, interpersonal skills, social responsibility, and value-based decision-making required across various engineering and professional careers. The course enhances employability skills such as:

- Ethical and professional conduct
- Teamwork and leadership
- Communication and interpersonal relations
- Problem-solving and responsible decision-making
- Environmental and social awareness
- Stress management and self-discipline

These competencies help students become socially responsible and professionally competent engineers capable of contributing positively to industry and society.



Program:		S. Y. B. Tech		Semester:		III	
Course:		Material Testing and Characterization Lab		Course Code:		R25-ME-PCC-208	
Teaching Scheme				Examination Scheme			
Lecture	Practical	Tutorial	Credit	CCE	ESE	TW	OR
--	02	--	01	--	--	--	50
Course Description and Relevance: A Material Testing and Characterization Lab is a specialized facility where move from theory to practice by scientifically measuring the mechanical properties of materials. In the testing phase, specimen is subjected to physical forces—such as pulling, bending, or striking them—using equipment like Universal Testing Machines and Impact Testers to determine their strength, elasticity, and durability. The characterization phase goes deeper, using advanced tools like optical microscopes or X-ray diffraction to examine the material’s internal things such as its grain structure and chemical composition. By combining these two areas, the lab allows to see exactly how a material's microscopic structure dictates its real-world performance, providing the essential data needed to ensure engineering designs are both safe and efficient. This subject is fundamental because it transforms theoretical science into practical, safe engineering. By mastering the relationship between a material’s internal structure and its mechanical response, students gain the ability to predict exactly how a component will behave under pressure. This knowledge is crucial for ensuring structural integrity; it allows an engineer to determine if a machine part will snap, or if a specific heat treatment can make a tool more durable. Ultimately, it equips students with the analytical tools to select the most efficient materials and designs, balancing cost and weight against the absolute necessity of preventing catastrophic failure in the real world.							
Prerequisite: 1. Engineering Mechanics 2. Engineering Chemistry 3. Manufacturing Process Workshop							
Bridge Content: 1. In the same semester Engineering Materials & Metallurgy and Solid Mechanics courses are in syllabus to fulfill bridge content required for Material Testing & Characterization Lab syllabus.							
Course Objectives: 1. To acquire basic knowledge of stress, strain due to various types of loading for different types of materials. 2. To determine Bending, Shear stress, Slope and Deflection on Beam. 3. To establish significance of structure property relationship. 4. To indicate the importance of heat treatment on structure and mechanical properties of materials. 5. To explain the material selection process							
Course Outcomes: After learning the course, students will be able to							
CO	Course Outcome						Bloom’s Level
1	PERFORM tensile, compression, torsion, shear and impact, hardness tests on engineering materials.						3
2	VERIFY flexural bending behavior of cantilever and simply supported beams using strain gauges.						3
3	ANALYZE engineering components using suitable Non- Destructive Testing methods to identify failure causes.						4



4	INTERPRET microstructures and material test reports of ferrous and non-ferrous materials.	2
5	SELECT appropriate engineering materials considering functional, environmental requirements using ASTM standards.	3
Course Content		
List of Practical:		
Experiment No.1	Tension / Compression Test	COs Mapped CO1
2 Hrs. Objective: To conduct tensile or compression test on ductile or brittle material and Validate the experimental results with other materials. Associated Tasks: 1. Prepare the Specimens & Setup the Equipment: Mount the specimen into the Universal Testing Machine (UTM) and attach an extensometer to accurately measure deformation. 2. Execute the Test: Apply a gradual load until the material reaches its breaking point, recording the force and displacement data throughout. 3. Analyse Failure Modes: Observe the fracture site to identify characteristic failure patterns, such as "cup and cone" for ductile materials or a flat, sudden break for brittle ones. 4. Generate Stress-Strain Plots: Calculate the stress and strain from your raw data to plot a curve, identifying key points like the Yield Point and Ultimate Tensile Strength. 5. Perform Comparative Validation: Compare experimental curve against standard reference plots for other materials (like aluminum or high-carbon steel) to conclude how your samples differ in stiffness and toughness. Exemplars and Utility: 1. Aerospace Industry: Validation of aircraft structural components (e.g., wing spars, fuselage frames). 2. Automotive Engineering: Crashworthiness and durability of vehicle frames and body panels 3. Obtained result and conclusion leads to understand Predicting Failure, Safety Assurance, Material Optimization and Quality Control.		
Experiment No.2	Torsional / Shear test	COs Mapped CO1
02 Hrs. Objective: To Conduct torsional / shear test on ductile material. Case study on part failure under torsion/shear Associated Tasks: 1. Specimen Measurement: Measure the gauge length and diameter of the ductile sample (e.g. mild steel or aluminum) to calculate its polar moment of inertia. 2. Machine Setup: Secure the specimen in a Torsion Testing Machine, ensuring the grips are tight to prevent slipping during twisting. 3. Data Collection: Gradually apply torque and record the corresponding angle of twist until the material reaches its shear yield point and eventual fracture. 4. Calculate Modulus of Rigidity (G): Use the torque and twist data to determine the material's stiffness in shear. Analyze Failure Surface: Examine the fracture—ductile materials under torsion typically fail along a plane perpendicular to the axis (a flat, smooth break), showing a "shear" failure. 6. Case Study Investigation: Review a historical or simulated failure report (e.g., a snapped driveshaft) to identify if the failure was due to overloading, fatigue, or material flaws. Exemplars and Utility: 1. Automotive Drive Shafts: Testing the steel shafts that transfer power from the engine to the wheels; they must handle high torque without twisting permanently.		



2. Industrial Drill Bits: Analyzing how much "twist" a drill bit can take when it hits a hard knot or metal pocket before it shears off.
3. Helical Springs: Since springs work by twisting the wire, shear testing determines how much weight a vehicle's suspension can support.

This test gives clear information about preventing failures, weight reduction by using hollow shaft, safety in rotating parts and root cause analysis about failure.

Experiment No.3	Impact Test	COs Mapped CO1	02 Hrs.
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Objective: To conduct Charpy / Izod Impact Test for Steel, Aluminum, Brass and Copper. Failure case studies under impact loading of any one material.

Associated Tasks:

1. Notch Preparation: Precisely cut a V-shaped notch into the specimens (Steel, Aluminum, Brass, Copper) to create a stress concentrator.
2. Calibration: Zero the Charpy/Izod Impact Tester pendulum to account for friction and windage losses.
3. Experimental Trials: Release the pendulum to strike each specimen and record the energy absorbed (usually in Joules) indicated on the dial.
4. Surface Analysis: Compare the fracture surfaces, look for shiny/grainy surfaces (brittle) versus dull/fibrous surfaces (ductile).
5. Case Study Analysis: Study a specific failure and compare with test specimen.

Exemplars and Utility:

1. Automotive Industry - Testing car bumpers, chassis, doors, and crash structures.
2. Aerospace Industry - Impact testing ensures wings, fuselage materials, and turbine components resist cracking.
3. Railway and Transportation - Rails, wheels, and couplings face repeated impact loading.
4. Impact test helps engineer to Determine Toughness of Materials, Detecting Brittle Behavior, Material Selection and Quality Control in Manufacturing.

Experiment No. 4	Verify Flexural Formula	COs Mapped CO2	02 Hrs.
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Objective: To experimentally verify the flexural bending formula for cantilever and simply supported beams using strain gauges. Case study on cantilever and simply supported structures and their failure.

Associated Tasks:

1. Experimental setup – Prepare cantilever and simply supported beam setups with proper loading arrangements. Mount strain gauges at critical locations on the beam surface.
2. Collecting data – Apply incremental loads and record strain readings. Calculate bending stress and strain theoretically using the flexural formula. Compare theoretical values with experimentally obtained results.
Plot load vs. strain and stress vs. strain graphs. Observe beam deflection and identify possible failure modes.
4. Conduct a case study on structural failures in cantilever and simply supported beams due to overloading, fatigue, improper design, or material defects.

Exemplars and Utility:

1. Aerospace and Automotive Applications – Evaluation of bending stresses in aircraft wings, automobile frames, suspension components, and lightweight structural members.
2. Design Validation in Mechanical Engineering Structures like Support arms, Robotic limbs, Levers.
3. Helps in understanding the practical application of the flexural bending theory. Develops skills in experimental stress analysis using strain gauges. Enables validation of structural designs before real-world implementation.



Experiment No. 5	Hardness Test	COs Mapped CO1	02 Hrs.
Objective: To conduct material Hardness test using Brinell's / Vicker's / Rockwell Hardness testing set up. Test samples should be before and after case harden and core harden heat treatment. Visit to heat treatment plant/lab for hardening process. Associated Tasks: 1. Preparation of Test Samples and Conducting Hardness Tests - Prepare surfaces by grinding and polishing for accurate indentation measurement. Conduct test as per standard procedure. 2. Collecting data and calculate hardness – note reading from machine and measure diameter of indentation produce on specimen. Calculate BHN or note Rc number. 3. Heat treatment – carryout heat treatment on specimen and again conduct hardness test to compare result. 4. Analysis and interpretation - Analyze variation in hardness. Correlate hardness with wear resistance, strength, and toughness. 5. Industrial Visit Activities – Observe industrial furnaces and quenching methods. Study temperature control and cooling media. Understand quality inspection procedures in heat treatment plants. Exemplars and Utility: 1. Gear manufacturing – Steel gears before and after case hardening. Case hardening increases surface hardness while maintaining a tough core. 2. Automotive components – camshafts and crankshafts after core hardening and induction hardening. Hardness testing verifies durability of rotating components. 3. Hardness test helps engineer to understand quality assurance, select proper material for required application, failure prevention, industrial process control, effect of heat treatment on hardness of material.			
Experiment No. 6	Non-Destructive Tests	COs Mapped CO1	02 Hrs.
Objective: To analyze a given sample using a suitable Non-Destructive Testing. The study also aims to investigate failure causes in components collected from automobiles, machinery, household appliances. Associated Tasks: 1. Collect failed or suspected samples from automobiles, machine parts, household appliances, welded joints, shafts, or structural members. Prepare and clean the sample surface before testing. 2. Conduct the selected NDT procedure: Dye Penetrant Test, Magnetic Particle Test (MPT) Ultrasonic Test (UT) 3. Observe and record indications of cracks, voids, inclusions, porosity, or other defects. 4. Interpret test results and identify the nature and location of defects. 5. Analyze possible causes of failure such as fatigue, corrosion, improper welding, overload, or manufacturing defects. 6. Compare advantages and limitations of different NDT techniques. Exemplars and Utility: 1. Inspection of welded joints in pressure vessels and pipelines. 2. Detection of surface cracks in turbine blades, aluminum components, and machine casings. 3. Detection of fatigue cracks in gears, crankshafts, and connecting rods. 4. Thickness measurement and integrity testing in aerospace and shipbuilding industries. NDT Enables defect detection without damaging the component under inspection, improves safety and reliability of engineering structures and machine parts, helps in early identification of cracks and flaws before catastrophic failure occurs, reduces maintenance costs and downtime by preventive inspection.			



Experiment No. 7	Microstructure Analysis	COs Mapped CO4	02 Hrs.
Objective: Interpretation and Drawing of Microstructures of Ferrous (Steel, cast iron) and Non-ferrous materials (Aluminum, nickel) of various compositions. Visit to test lab for Reading and interpretation of standard material test report (certificate) of ferrous and non-ferrous materials Associated Tasks: 1. Select material and cur required sample. Prepare polished and etched specimens. 2. Observe specimens using metallurgical microscope. 3. Identify constituents/phases such as: Ferrite, Pearlite, Cementite, Graphite flakes/nodules, Austenite, Martensite. 4. Draw observed microstructures neatly with labels. 5. Study standard industrial certificates containing: Chemical composition, Tensile strength, Yield strength, Hardness, Impact values, Heat treatment condition, ASTM/IS standards Exemplars and Utility: 1. Ferrous Materials: Low Carbon Steel (0.6% C) - Predominantly pearlite with some cementite, 2. Gray Cast Iron - Graphite flakes in a pearlitic or ferritic matrix, White Cast Iron - Cementite and pearlite, no graphite This activity is highly useful in mechanical and manufacturing engineering because it helps students: to interpret microstructure, to identify phases in it, to learn effect of HT on microstructure.			
Experiment No. 8	Case study on material selection	COs Mapped CO5	02 Hrs.
Objective: To conduct Case Study on Material Selection Considering Functional and Environmental Requirements and Identification of ASTM Standards. Associated Tasks: 1. Identification of Product/Application - Select an engineering product or system such as: Pressure cooker. 2. Study functional and environmental requirement – strength, recyclability etc 3. Selection of Candidate Materials – Identify at least 2–3 possible materials and Compare their properties. 4. Final Material Selection – most suitable material for given application. 5. Identification of ASTM Standards & Preparation of Comparative Analysis Table. 6. Preparation of report. Exemplars and Utility: 1. Pressure Cooker Body Material 2. Microwave Oven Cavity Material 3. Mixer Grinder Blade Material 4. Electric Iron Soleplate Material Food Processing Equipment Material			
Textbooks: 1. S. Ramamurtham, —Strength of material, Dhanpat Rai Publication 2. S.S. Rattan, —Strength of Material, Tata McGraw Hill Publication Co. Ltd. 3. Dr. V. D. Kodgire & S. V. Kodgire, —Material Science & Metallurgy For Engineers, Everest Publication.			
Reference Books: 1. G. H. Ryder, —Strength of Materials, Macmillan Publication 2. James M. Gere, —Mechanics of Materials, CL Engineering 3. George Ellwood Dieter, —Mechanical Metallurgy, McGraw-Hill 1988 4. A. K. Bhargava, C.P. Sharma, —Mechanical Behaviour & Testing of Materials, P H I Learning Private Ltd			


Virtual Lab, related open source/ subscription based software, Links or websites for lab conduction, animation, simulation etc., e-learning.

1. Tensile Test on V-Lab - <https://sm-nitk.vlabs.ac.in/exp/tensile-test-mild-steel/simulation.html>
2. Material Selection Criteria - https://www.youtube.com/watch?v=oWYyt_5pY44
3. NDT - <https://www.ansi.org/standards-news/member-updates/12-18-24-asnt-unveils-new-animated-videos-on-nondestructive-testing>

CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1	1	-	1	1	1	2	1	3
CO2	3	3	2	1	1	1	1	-	1	1	1	3	1	2
CO3	3	3	2	2	1	1	1	-	1	1	1	2	1	3
CO4	3	2	1	1	1	1	1	-	1	1	1	2	1	2
CO5	2	3	3	2	1	2	2	1	2	2	2	3	2	3
Avg.	2.8	2.6	1.8	1.4	1	1.2	1.2	1	1.2	1.2	1.2	2.4	1.2	2.6

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern

BT Level	CCE based on ARCV							
	Exp. 1	Exp. 2	Exp. 3	Exp. 4	Exp. 5	Exp. 6	Exp. 7	Exp. 8
CO	CO1	CO1	CO1	CO2	CO1	CO3	CO4	CO5
L1								
L2							06	
L3	06	06	06	06	06			06
L4						08		
L5								
L6								

This course serves as a prerequisite for / maps with the following future courses:

1. Engineering Materials and Metallurgy
2. Manufacturing Processes
3. Composite Materials
4. Finite Element Analysis
5. Product Design and Development

Job Mapping:

Job opportunities that one can get after learning this course:

1. Material Testing Engineer
2. Failure Analysis Engineer
3. Metallography Technician
4. R&D Engineer (Materials and Metallurgy)
5. Production Engineer



Program:	S. Y. B. Tech				Semester:		III
Course:	Geometric Dimensioning and Tolerancing and Geometric Modelling				Course Code:		R25-ME-PCC-209
Teaching Scheme				Examination Scheme			
Lecture	Practical	Tutorial	Credit	CCE	ESE	TW	PR
--	2	--	--	--	--	25	25
Course Description and Relevance: This course provides a comprehensive bridge between conceptual design and precision manufacturing. It is designed to equip students with the dual expertise of creating sophisticated digital geometries and communicating engineering intent through standardized technical language. By integrating Geometric Modeling with Geometric Dimensioning and Tolerancing (GD&T), the syllabus ensures that students can move beyond basic drafting to develop production-ready digital twins that adhere to global industry standards such as ASME Y14.5 . GD & T focuses on the functional relationship of parts. GD & T covers the Datum System, Form, Orientation, Profile, Location, and Runout Material Condition Modifiers, dimensional tolerance and surface roughness symbol. Geometric modeling covers sketching, 3D modelling of machine parts, assembly and generating drawing views. In the modern manufacturing landscape, the ability to design a part is only half the battle; the other half is ensuring it can be manufactured, assembled, and serviced at a global scale. This subject is the cornerstone of Design for Manufacturing (DFM) and Design for Assembly (DFA) . Engineering is a global language. A design created in Maharashtra might be manufactured in Germany and assembled in the USA. Importance: GD&T provides a mathematically defined language (ASME/ISO) that ensures a drawing has only one interpretation. This eliminates "guesswork" on the shop floor and reduces expensive rework or scrap.							
Prerequisite: 1. Systems in Mechanical Engineering, Engineering Graphics.							
Bridge Content: 1. Introduction to BIS (Bureau of Indian Standards) SP-46. 2. The concept of Variability. Understanding that no part can be manufactured to an exact size. 3. Real-world geometric imperfections. While a line looks straight on paper, in reality, it may have "waviness." This bridges the need for Geometric Tolerances (Form, Orientation, and Profile) to control the "shape" of the part beyond just its size. 4. Degrees of Freedom (DOF). Understanding how parts move relative to each other in an assembly.							
Course Objectives: 1. To familiarize students with standard drawing practices and Bureau of Indian Standards (SP-46) conventions for the accurate representation and dimensioning of machine components and engineering materials. 2. To enable students to understand and apply the principles of the limit system, including the selection and calculation of fits and tolerances using hole and shaft basis systems to ensure functional assembly and manufacturability of mechanical parts. 3. To provide students with the knowledge to specify and interpret geometric tolerances, surface texture requirements, and welding symbols using international standards and feature control frames to communicate precise design intent and manufacturing constraints. 4. To introduce the evolution and types of geometric modeling—including wireframe, surface, and solid modeling and to develop fundamental proficiency in creating constrained 2D sketches using standard CAD software tools. 5. To develop the ability to create parametric 3D solid models from constrained 2D sketches using feature-based operations and to perform analytical evaluations of mass properties by applying appropriate engineering materials. 6. To equip students with the skills to develop complex mechanical assemblies using various modeling approaches and to generate comprehensive 2D production drawings, including exploded views and Bill of Materials (BOM), to facilitate effective manufacturing and assembly.							



Course Outcomes: After learning the course, students will be able to			
CO	Course Outcome	Bloom's Level	
CO1	Represent the IS conventions of machine components.	3	
CO2	Determine appropriate limits, fits, and tolerances to ensure functional assembly and perform tolerance stack-up analysis for mechanical components.	3	
CO3	Interpret geometric tolerances, surface finish specifications, and welding symbols on production drawings to ensure precise functional requirements and manufacturability of mechanical components.	2	
CO4	Create constrained 2D sketches using standard CAD tools.	3	
CO5	Construct parametric 3D solid models from constrained 2D sketches using feature-based operations—such as extrude, revolve, and sweep etc.	3	
CO6	Develop comprehensive assembly models and generate standardized 2D production drawings featuring exploded views, Bill of Materials (BOM), and GD&T annotations to facilitate manufacturing and assembly processes.	3	
Course Content			
List of Practicals:			
Experiment No.1	IS Conventions	COs Mapped CO1	Hrs. 2
Objective: 1. Interpret and apply standard drawing layouts and scales according to IS: SP-46. 2. Demonstrate proficiency in dimensioning techniques specific to complex machine features. 3. Utilize conventional representations to simplify the drawing of standard mechanical components (gears, springs, threads) without compromising technical accuracy. 4. Recognize and symbolize common machining operations like counterboring, countersinking, and knurling.			
Associated Tasks: 1. One A2 size sheet on Assembly of simple mechanical system (Manually). 2. One A2 size sheet on Details of simple mechanical system (Manually).			
Exemplars and Utility:			
A) Exemplars: 1. The Gear-Shaft Assembly: Draw a splined shaft carrying a spur gear. Use conventional symbols for the gear teeth and splines rather than drawing every profile. 2. Fastener Details: Represent a sectional view of a tapped hole with a bolt engaged, showing the correct convention for external and internal screw threads. 3. Surface Finishes: Apply the conventional representation for knurling (diamond or straight) on a handle component.			
B) Utility: 1. Universal Communication: Engineering drawings are a language. Following SP-46 ensures that a design made in one city can be manufactured in another without misinterpretation. 2. Drafting Efficiency: Conventional representations (like those for springs or gears) save significant time. Instead of drawing complex helical curves, an engineer uses standard "zig-zag" or simplified lines that everyone understands. 3. Foundation for CAD: Before moving to 3D Geometric Modeling, a student must understand these 2D conventions, as modern CAD software (SolidWorks, CATIA, AutoCAD) uses these exact standards to generate automated 2D production drawings.			
Experiment	Limits, Fits and Dimensional Tolerances	COs Mapped	Hrs.



No.2		CO2	4
Objectives: - To define and calculate fundamental terminology including basic size, actual size, deviations, and fundamental deviations. - To differentiate and apply unilateral and bilateral tolerances based on the design intent of the component. - To analyze the relationship between IT grades and the capability of specific manufacturing processes (e.g., grinding vs. sand casting). - To select and justify specific fits (Clearance, Transition, or Interference) for diverse mechanical applications using Hole and Shaft basis systems. - To perform Tolerance Stack-up Analysis to evaluate the cumulative effect of individual part tolerances on the final assembly. Associated Tasks: - Fit Calculation: Given a basic size and a fit designation (e.g., 40H7/g6), calculate the upper and lower limits for both the hole and the shaft and decide the type of fit. - Assignment on tolerance Stack-up analysis. Exemplars and Utility: A) Exemplars: - Clearance Fit (H7/g6): The interface between a Lathe Spindle and its bearings, where free rotation is essential. - Interference Fit (H7/p6): A Bush pressed into a Gear hub, where the parts must move as a single unit without fasteners. - Transition Fit (H7/js6): The alignment of a Spigot on a flange, where accurate location is needed with easy assembly/disassembly. - Tolerance Stack-up: Calculating the total axial play in a Gearbox Input Shaft assembly involving the shaft length, gear width, and snap ring thickness. B) Utility: - Interchangeability: This is the most critical utility. It allows a factory to buy a bearing from one vendor and a shaft from another, knowing they will fit perfectly based on the specified IT grades. - Cost Optimization: Students learn that tighter tolerances (lower IT grades) increase manufacturing costs exponentially. This unit teaches them to specify the loosest tolerance that still functions, saving the company money. - Design Validation: Tolerance stack-up analysis allows engineers to predict if an assembly will fail before a single part is actually machined, reducing prototype waste.			
Experiment No.3	Geometrical Tolerances & Surface Finish & Welding Symbols	COs Mapped CO3	Hrs. 4
Objectives: - Apply GD&T Logic: Explain the need for geometric tolerances over traditional coordinate dimensioning to ensure functional assembly. - Master Material Modifiers: Differentiate between Maximum Material Condition (MMC) and Least Material Condition (LMC) and calculate "bonus tolerances." "Decode Feature Control Frames: Read and write the "sentences" of GD&T that define the characteristic, tolerance zone, and datum references. - Evaluate Surface Quality: Interpret surface roughness symbols and correlate required Ra values with specific manufacturing processes. - Communicate Fabrication: Apply standard welding symbols to specify the type, size, and finish of welded joints on structural drawings. Associated Tasks: Apply GD&T symbols to a drawing which is drawn in associated task no. 2 in Expt. No. 1. Exemplars and Utility:			



A) Exemplars:

1. Flatness & Parallelism: Specifying the flatness of a Surface Plate or the parallelism between the top and bottom faces of a Milling Machine Vise.
2. Circularity vs. Cylindricity: Controlling the roundness of a Piston Ring (Circularity) versus the entire length of a Hydraulic Ram (Cylindricity).
3. Surface Texture: Specifying the "lay" and roughness of a Cylinder Bore to ensure oil retention and minimize friction.
4. Welding: Using a "Weld-All-Around" symbol for a circular pipe-to-flange joint.

B) Utility:

1. Functional Gauging: GD&T allows for the design of physical "Go/No-Go" gauges, which makes inspection on the shop floor significantly faster than using CMM (Coordinate Measuring Machines) for every part.
2. Performance Life: Correct surface finish (Surface Texture) is the primary factor in determining the wear rate of moving parts. Improper Ra values lead to premature failure of seals and bearings.
3. Structural Integrity: In fabrication, an incorrect welding symbol can lead to under-sized welds or the wrong joint type, potentially leading to catastrophic structural failure in cranes, bridges, or pressure vessels.

Experiment No.4	Introduction to Geometric Modeling and Sketching	COs Mapped CO4	Hrs. 2
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Objectives:

1. Compare conventional 2D drafting with 3D geometric modeling to identify how digital models overcome the limitations of ambiguity and manual revision in 2D drawings.
2. Categorize and distinguish between Wireframe, Surface, and Solid Modeling.
3. Trace the development of CAD and its critical role in modern "allied technologies" like Computer-Aided Manufacturing (CAM) and Computer-Aided Engineering (CAE).
4. Demonstrate proficiency in navigating a professional-grade Graphical User Interface (GUI).
5. Utilize fundamental drawing tools—such as lines, circles, arcs, and polygons—to create accurate 2D profiles that serve as the foundation for 3D features.
6. Implement modifying tools like Trim, Mirror, Offset, and Pattern to streamline the design process and maintain geometric consistency.
7. Apply both Geometric Constraints (parallelism, tangency, symmetry) and Dimensional Constraints to create "fully defined" sketches.

Associated Tasks: Assignment on 2D sketching.

Exemplars and Utility:

A) Exemplars

Mechanical part design, Architectural drafting, Electrical circuit layout, Automotive component modeling, Product prototyping and visualization.

B) Utility

The foundation for 3D Printing (Additive Manufacturing) and Finite Element Analysis (FEA).

Explains why we model in 3D: to feed data directly into CNC machines (CAM) or simulation software (CAE) without manual re-entry.

Experiment No.5	Solid modeling	COs Mapped CO5	Hrs. 6
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Objective:

1. **Execute** 3D transformations by selecting the appropriate feature operation (Extrude, Revolve, Sweep) for a given geometry.
2. **Implement** parametric design intent so that changes in one dimension automatically update the entire model logic.
3. **Calculate** physical attributes (mass, volume, center of gravity) by assigning real-world material properties to digital solids.

Associated Tasks:

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Assignment on solid modeling.

Exemplars and Utility:

A) Exemplars

Automotive body and chassis design, Aerospace structural component modeling, Consumer product design and development, Industrial machinery and equipment design, Architectural modeling and building information modeling (BIM)

B) Utility

Ensures "Design Intent." If a hole must always be in the center of a plate, a constraint ensures it stays there even if the plate size changes.

Parametric modeling allows for "Family of Parts" creation. A company can create one master file for a bolt and generate 100 sizes just by changing a spreadsheet of values.

Experiment No.6	Assembly Modeling & Drafting	COs Mapped CO6	Hrs. 4
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Objective:

1. **Differentiate** between Top-Down and Bottom-Up assembly approaches and select the appropriate method for a given design project.
2. **Apply** assembly mates (coincident, concentric, tangent, etc.) to eliminate degrees of freedom and simulate mechanical movement.
3. **Generate** standard engineering views (orthographic, section, and isometric) from 3D data with associative links.
4. **Construct** an Exploded View and a Bill of Materials (BOM) to facilitate assembly sequence planning.
5. **Apply** GD&T symbols and technical dimensions to 2D drawings according to international standards (ISO/ASME).

Associated Tasks:

1. Assignment on assembly and generation of production drawings of machine components like knuckle joint, coupling, gate valve, stop valve, Bench vice, tool post etc. with appropriate tolerancing.
2. A group mini project on industrial assembly of any mechanism / machine with drafting

Exemplars and Utility:

A) Exemplars

Automotive engine assembly design, Aerospace system integration, Consumer electronics product assembly, Industrial machinery assembly planning, Robotics and automation system design. Automotive manufacturing documentation, Aerospace component assembly instructions, Consumer electronics product manuals, Industrial equipment fabrication, Construction and architectural detailing

B) Utility

Exploded views essential for service manuals, assembly line instructions, and marketing / sales catalogs. Bill of materials is the bridge between engineering and procurement. Used by the ERP system to order materials and manage inventory. GD & T in drafting communicates —design intent to the machinist. It ensures that parts from different suppliers will fit together perfectly every time.

Textbooks:

1. Machine Drawing, K. L. Narayana, P. Kanniah, & K.V. Reddy, SciTech Publications
2. Production Drawing, K. L. Narayana, P. Kanniah, & K.V. Reddy, New Age International Pvt Ltd

Reference Books:

1. IS Code: SP 46 – 1988, Standard Drawing Practices for Engineering Institutes
2. Machine Drawing, ND Bhat, Charotar Publishing House
3. Machine Design, Sadhu Singh, Khanna Book Publishing, 2021.
4. Fundamentals of Machine Component Design, Juvinal, R.C., John Wiley, 1994.
5. R. L. Norton, —Mechanical Design – An Integrated Approach, Prentice Hall, 2009.



6. Sadhu Singh, —Machine Design Data Book, Khanna Book Publishing, 2022.
7. Computer Aided Engineering Drawing, S. Trymbaka Murthy, I.K. International Publishing House Pvt. Ltd, Pune
8. Engineering Drawing and Computer Graphics, Shah, Pearson
9. Geometric Dimensioning and Tolerancing for Mechanical Design, Cogorno, G. R., (2020), 3rd edition, McGraw-Hill Education.
10. Geometric Dimensioning and Tolerancing: A Complete Guide, Blokdyk, Gerardus, (2019), 2020 Edition", 5STARCOoks.

Codes / Handbooks

Standards: ASME Y14.5 – 2018

Standards: ISO/TR 23605:2018, ISO 1101:2017, SP 46, IS 15054(2001)

Virtual Lab, related open source/ subscription-based software, Links or websites for lab conduction, animation, simulation etc., e-learning.

1. <https://geotol.com/resources/>
2. <https://www.sae.org/learn/professional-development/gdt>

Useful websites / Video

1. <https://youtu.be/0IgOapAtauM>
2. <https://youtu.be/aS9OgYadjpY>
3. <https://nptel.ac.in/courses/112/104/112104250/>
4. <https://nptel.ac.in/courses/112/104/112104193/>
5. <https://nptel.ac.in/courses/112/104/112104031/>
6. <https://nptel.ac.in/courses/112/105/112105294/>

*Add additional rows as per requirement

CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	3	-	1	3	-	2
CO2	3	3	2	-	-	-	-	-	-	-	1	3	-	2
CO3	3	2	3	-	-	2	1	-	3	-	1	3	-	3
CO4	2	2	-	-	3	-	-	-	-	-	1	2	-	1
CO5	2	-	2	-	3	-	-	-	-	-	1	3	-	1
CO6	2	-	3	1	3	-	-	2	3	2	2	3	-	3
Avg.	2.5	2.33	2.5	1	3	2	1	2	9	2	1.4	2.83	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern

BT Level	CCE based on RCV					
	Exp. 1	Exp. 2	Exp. 3	Exp. 4	Exp. 5	
CO	CO1	CO2	CO3	CO4	CO5	
L1						
L2			15			
L3	15	15		15	15	
L4						
L5						
L6						

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TERM WORK

Sr. No.	Components for Term work Assessment	Marks Allotted
1	Assignments on GD & T	15
2	Assignments on Geometric modeling	10
	Total	25

Practical Exam details

- 3D modeling of one simple assembly – 20 marks
- One numerical on deciding type of fit for 2-part assembly – 5 marks

This course serves as a prerequisite for / maps with the following future courses:

1. Machine Design II / Design of Transmission Systems
2. Finite Element Analysis (FEA)
3. Design for Manufacturing and Assembly (DFMA)
4. Computer-Aided Manufacturing (CAM)
5. Metrology and Quality Control

Job Mapping:

Job opportunities that one can get after learning this course:

1. Mechanical Design Engineer
2. Product Development Engineer
3. CAD Specialist / Geometry Developer
4. Manufacturing Engineer
5. CNC Programmer
6. Quality Assurance (QA) Engineer



Program:	S. Y. B. Tech			Semester:	III		
Course:	Community Engagement Project			Course Code:	R25-ME-ECEP-210		
Teaching Scheme				Examination Scheme			
Lecture	Practical	Tutorial	Credit	CCE	ESE	TW	PR
--	04	--	2	--	--	50	--
Course Description and Relevance: The Community Engagement Project is a practical and field-based course designed for Mechanical Engineering students to understand real-life problems faced by rural and urban communities. The course encourages students to use their engineering knowledge and skills to support society in a sustainable and responsible way. Through this course, students interact with local communities, conduct surveys, study local conditions, and identify problems related to basic utilities and infrastructure. The identified issues are connected with initiatives such as Unnat Bharat Abhiyan, Unnat Maharashtra Abhiyan, and the United Nations Sustainable Development Goals (SDGs). Students work on simple, low-cost, and useful engineering solutions. They may also conduct technical awareness programs, demonstrate small prototypes, carry out audits, and study the impact of their work on the community. The course helps students develop practical knowledge, teamwork, communication skills, problem-solving ability, social responsibility, sustainability awareness, and technical documentation skills. It creates a strong connection between engineering education and community development. The main purpose of introducing the Community Engagement Project is to connect classroom learning with real social and community problems. Although students gain theoretical and laboratory knowledge in the institute, they also need exposure to actual field conditions where engineering solutions are required. Many communities face problems related to water management, sanitation, waste disposal, farm utilities, energy conservation, public infrastructure, and local livelihood activities. In many such areas, simple and low-cost engineering solutions can make a positive impact on society. This course is designed in line with national initiatives such as Unnat Bharat Abhiyan and Unnat Maharashtra Abhiyan, as well as global sustainability goals promoted by UNESCO and the United Nations Sustainable Development Goals (SDGs). The course aims to develop social responsibility, practical learning, teamwork, innovation, and professional skills among students while encouraging institutions to actively contribute to sustainable community development.							
Prerequisite: Fundamental concepts of engineering and technology; Willingness to work in groups for social cause.							
Bridge Content: 1. Understanding of simple survey methods, observation, and data recording 2. Basic understanding of social issues, environmental concerns, and sustainable development. 3. Problem-solving methodology. 4. Computer and documentation Skills							
Course Objectives: 1. Develop awareness of societal, rural and environmental challenges through direct community engagement. 2. Identify community needs and local developmental problems using participatory field survey methods. 3. Analyze the selected problems in the context of sustainability, UBA/UMA initiatives and SDG framework. 4. Design appropriate low-cost mechanical engineering interventions for community improvement. 5. Evaluate the technical, social and environmental impact of the proposed community engagement activities.							
Course Outcomes: After learning the course, students will be able to							
CO	Course Outcome						Bloom's Level
CO1	CONDUCT community interaction, baseline survey and stakeholder need assessment systematically.						3



CO2	CLASSIFY and prioritize identified local problems using participatory and sustainability-based analysis tools.	4
CO3	CORRELATE community issues with UBA/UMA themes and relevant Sustainable Development Goals.	4
CO4	PROPOSE feasible mechanical engineering solutions, technical audits or awareness interventions for selected problems.	6
CO5	ASSESS the effectiveness and impact of the implemented community engagement project through documentation and feedback.	5

Course Content**List of Practical:**

Experiment No.1	Community Orientation Visit and Stakeholder Interaction	COs Mapped CO1	Hrs.
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Objective:

To provide students with initial field exposure for understanding the socio-technical conditions of the adopted community and to identify local developmental issues through direct interaction with stakeholders and field observations.

Associated Tasks:

1. Visit the adopted village, urban ward, community cluster, or institutional area and interact with local stakeholders such as: Gram Panchayat members, Local administrative officers, Teachers, Farmers, Self-help groups, Health workers and Community residents
2. Observe local conditions related to: Water supply, Sanitation, Waste management, Energy usage, Public infrastructure, Livelihood activities
3. Conduct preliminary discussions to understand community needs and expectations.
4. Prepare stakeholder lists and maintain field notes.
5. Record observations using photographs, sketches, or survey sheets.
6. Identify and document major visible community problems.

Exemplars and Utility:

Observation of improper waste disposal practices in the village; Identification of water leakage or poor drainage systems; Interaction with farmers regarding irrigation or farm equipment issues; Study of energy usage patterns in schools or community buildings; Documentation of sanitation and public utility conditions.

Helps students understand real-life community problems, Develops communication, observation, and field survey skills; Creates awareness about social responsibility and sustainable development; Provides a foundation for identifying engineering-based solutions; Strengthens teamwork, documentation, and stakeholder interaction abilities.

Experiment No.2	Baseline Household Survey and Community Profiling	COs Mapped CO2	Hrs.
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Objective:

To enable students to understand the socio-economic and infrastructural conditions of the community through systematic household survey, data collection and preparation of a community profile for identifying engineering-related problems and service gaps.

Associated Tasks:

1. Prepare a structured household survey questionnaire.
2. Identify selected households for conducting the baseline survey.
3. Collect demographic and economic information of households.
4. Gather data related to:
 - Water supply and usage
 - Sanitation facilities
 - Fuel consumption



- Electricity usage
- Farm tools and equipment
- Waste disposal practices
- Educational facilities and access
- Local transportation facilities
- Public utility maintenance issues
- 5. Interact with residents to understand common local problems.
- 6. Record and organize collected survey data systematically.
- 7. Analyze the collected information and identify service gaps.
- 8. Prepare a concise community profile report with observations and findings.

Exemplars and Utility:

Students may conduct household surveys to identify issues such as irregular water supply, lack of sanitation facilities, inefficient cooking fuel usage, poor waste disposal systems, inadequate farm equipment, electricity-related problems, or transportation difficulties. The collected information helps students understand the living conditions and practical challenges faced by the community. This activity develops communication skills, data collection and analysis ability, teamwork, and technical documentation skills. It also helps students recognize areas where simple and sustainable engineering solutions can improve community infrastructure, utility services, and quality of life.

Experiment No.3	Community Resource Mapping and Infrastructure Documentation	COs Mapped CO2	Hrs.
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Objective:

To help students understand the availability and condition of physical infrastructure and utility resources in the community through systematic field mapping and identification of areas requiring engineering support and improvement.

Associated Tasks:

1. Visit the selected community area for field observation and resource mapping.
2. Identify and record important physical and utility resources such as:
 - Roads and pathways
 - Drainage systems
 - Water sources and storage facilities
 - Schools and public buildings
 - Farms and agricultural work areas
 - Waste disposal or dumping locations
 - Electrical utilities and street lighting
 - Community service centers and common facilities
3. Prepare a social/resource map of the selected area.
4. Conduct field observations regarding the condition and usage of resources.
5. Document observations using:
 - Field notes
 - Sketches
 - Photographs
6. Identify locations where maintenance, utility improvement, or engineering intervention is needed.
7. Organize and present the collected information in report form.

Exemplars and Utility:

Students may prepare resource maps showing damaged roads, blocked drainage lines, water leakage points, improper waste dumping areas, poor street lighting, or inadequate public utility infrastructure. They may also identify locations where simple engineering improvements can support better community services and living conditions. This activity helps students develop observation, mapping, documentation, teamwork, and analytical skills. It also improves their understanding of infrastructure planning, resource management, and the role of engineering in solving community-level problems through practical and

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sustainable solutions.

Experiment No.4	Participatory Rural Appraisal and Local Need Prioritization	COs Mapped	Hrs.
Objective: To enable students to identify, analyze, and prioritize community problems through participatory interaction with local residents and stakeholders, ensuring that the selected issues reflect actual community needs and priorities.			
Associated Tasks: 1. Conduct group discussions and community interactions with local residents. 2. Organize focused discussions with different stakeholder groups such as: - Farmers - Women self-help groups - Youth groups - Local workers - Community leaders 3. Identify common local problems and developmental concerns. 4. Perform participatory appraisal activities such as: 5. Pairwise ranking 6. Need matrix preparation 7. Problem urgency analysis 8. Classify identified problems based on: - Social importance - Technical severity - Frequency of occurrence - Feasibility of engineering intervention 9. Compare observed field problems with community-prioritized issues. 10. Prepare a prioritized list of community problems. 11. Document discussion outcomes and analysis findings.			
Exemplars and Utility: Students may identify and prioritize issues such as water scarcity, poor drainage, inefficient farm tools, improper waste disposal, unsafe public utilities, or energy-related problems through direct discussions with community members. They may use simple ranking methods to determine which issues are most important to the community and which can be addressed through practical engineering support. This activity helps students understand participatory decision-making, community expectations, and the importance of selecting socially relevant projects. It also develops communication, analytical thinking, teamwork, and problem-prioritization skills while ensuring that engineering solutions are based on real community needs rather than only external observations.			
Experiment No.5	SDG, UBA and UMA Based Problem Mapping	COs Mapped CO3	Hrs.
Objective: To help students understand the connection between local community problems and national/global sustainability initiatives by mapping identified issues with Sustainable Development Goals (SDGs), Unnat Bharat Abhiyan (UBA), and Unnat Maharashtra Abhiyan (UMA) themes.			
Associated Tasks: 1. Review the local problems identified during surveys and field visits. 2. Study the thematic areas of: - United Nations Sustainable Development Goals (SDGs) - Unnat Bharat Abhiyan (UBA) - Unnat Maharashtra Abhiyan (UMA) 3. Analyze how community issues are related to sustainability and development goals. 4. Prepare a sustainability linkage sheet or mapping table.			



5. Correlate identified issues such as:

Water scarcity
 Sanitation problems
 Fuel inefficiency
 Waste accumulation
 Public hygiene issues
 Energy wastage
 Women drudgery
 with relevant SDGs and UBA/UMA themes.

6. Discuss the possible role of engineering solutions in addressing these issues.

7. Document observations and sustainability linkages in report form.

Exemplars and Utility: Students may map water supply problems with SDG 6 (Clean Water and Sanitation), energy wastage with SDG 7 (Affordable and Clean Energy), waste management issues with SDG 11 (Sustainable Cities and Communities), or women drudgery with rural development and livelihood-related themes under UBA and UMA. This activity helps students understand that local community problems are directly connected to larger national and global development goals. It develops sustainability awareness, mission-oriented thinking, analytical ability, and social responsibility among students. The assignment also encourages students to view engineering not only as a technical discipline but also as a means for achieving sustainable and inclusive community development.

Experiment No.6	Technical Problem Diagnosis and Root Cause Analysis	COs Mapped CO4	Hrs.
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Objective:

To enable students to investigate and analyze a selected community problem using engineering principles, field observations, and technical reasoning in order to identify its root causes and contributing factors.

Associated Tasks:

1. Select one major priority problem identified during community interaction and survey activities.
2. Conduct field visits for detailed technical investigation of the selected issue.
3. Collect relevant information through:
 - Field measurements
 - Direct observations
 - User interviews
 - Utility inspection
4. Study the operational and technical aspects related to the problem.
5. Perform root cause analysis of the issue.
6. Use analysis tools such as:
 - Cause-effect (fishbone) diagrams
 - Observation charts
 - Process flow mapping
7. Identify factors contributing to the problem such as:
 - Poor maintenance
 - Inefficient usage practices
 - Design limitations
 - Lack of mechanization
 - Resource wastage
8. Record findings systematically with sketches, photographs, and technical notes.
9. Prepare a technical diagnosis report with conclusions.

Exemplars and Utility:

Students may analyze problems such as continuous water leakage in pipelines, inefficient biomass fuel usage, improper waste collection practices, ergonomic discomfort during manual work, low efficiency of farm tools, or poor maintenance of public utilities. Through field observations and engineering analysis, students can identify the actual technical and operational causes behind the problem instead of only



observing its visible effects. This activity develops analytical thinking, engineering reasoning, field investigation skills, and systematic problem-solving ability. It also helps students understand how practical engineering methods can be used to study community-level problems and form the basis for developing effective and sustainable solutions.

Experiment No.7	Frugal Engineering Solution Ideation and Concept Generation	COs Mapped CO4	Hrs.
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Objective:

To encourage students to develop simple, low-cost, sustainable, and user-friendly engineering solutions for identified community problems using creative thinking, design approaches, and practical feasibility analysis.

Associated Tasks:

1. Review the technical diagnosis and root causes of the selected community problem.
2. Generate multiple possible engineering solutions through:
 - Brainstorming
 - Design thinking
 - Frugal innovation approaches
3. Prepare rough concepts, sketches, or layouts of proposed alternatives.
4. Analyze each alternative based on:
 - Simplicity of design
 - Local manufacturability
 - Cost effectiveness
 - Ease of operation and maintenance
 - Safety considerations
 - Social acceptability
 - Environmental suitability
5. Compare the proposed concepts using comparison charts or evaluation sheets.
6. Discuss feasibility of implementation with community members or stakeholders.
7. Select the most suitable intervention model for further development.
8. Prepare justification for the selected solution with technical reasoning.

Exemplars and Utility: Students may develop alternative solutions such as low-cost water-saving devices, improved waste collection systems, ergonomic farm tools, fuel-efficient cooking arrangements, simple mechanized utility systems, or maintenance support mechanisms for public facilities. They may compare different concepts based on cost, usability, maintenance requirements, and local resource availability before selecting the best option. This activity helps students develop creativity, innovation, engineering design skills, and decision-making ability. It also promotes sustainable and frugal engineering practices by encouraging solutions that are practical, affordable, safe, and suitable for local community conditions.

Experiment No.8	Engineering Design Proposal, Sketching and Cost Estimation	COs Mapped CO4	Hrs.
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Objective:

To enable students to transform a selected community-based engineering solution into a structured technical proposal with proper design details, material specifications, cost estimation, and implementation methodology.

Associated Tasks:

1. Finalize the selected engineering intervention or solution concept.
2. Prepare hand sketches and technical drawings of the proposed model.
3. Develop CAD layouts and dimensional plans wherever applicable.
4. Identify suitable materials required for fabrication or implementation.
5. Prepare:
 - Bill of Materials (BOM)



- Material specifications
- Estimated implementation cost
- 6. Design solutions related to:
 - Simple mechanical utilities
 - Hand-operated devices
 - Low-cost fixtures
 - Ergonomic support aids
 - Conservation attachments
 - Technical awareness models
- 7. Prepare a step-by-step implementation methodology including:
 - Fabrication process
 - Assembly steps
 - Installation procedure
 - User guidance or audit procedure
- 8. Document the proposal in technical report format with sketches, diagrams, and calculations.

Exemplars and Utility:

Students may prepare technical proposals for devices such as low-cost hand-operated agricultural tools, water-saving attachments, ergonomic carrying aids, waste segregation supports, fuel-efficient utility models, or simple maintenance fixtures for public infrastructure. They may develop engineering drawings, select locally available materials, estimate fabrication costs, and plan practical implementation procedures. This activity helps students apply engineering design knowledge to real community problems while developing technical drawing, CAD modeling, planning, costing, and documentation skills. It also promotes practical engineering thinking by encouraging feasible, affordable, and user-oriented solutions suitable for local conditions and community needs.

Experiment No.9	Prototype Development / Demonstration Model / Technical Audit Execution	COs Mapped CO5	Hrs.
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Objective:

To provide students with practical experience in implementing community-based engineering solutions through prototype development, demonstration activities, or technical audits and to evaluate their feasibility and usefulness in real conditions.

Associated Tasks:

1. Finalize the implementation plan for the selected project.
2. Develop and execute one of the following based on project type:
 - Functional prototype
 - Demonstration model
 - Mock-up model
 - Technical audit
3. Fabricate or assemble the required components for the prototype or model.
4. Conduct audits related to:
 - Household energy usage
 - Water consumption
 - Agricultural pump maintenance
 - Waste management practices
5. Perform field testing or demonstration of the developed solution wherever possible.
6. Interact with users or community members during implementation.
7. Observe operational performance and usability of the intervention.
8. Record:
 - Execution procedure
 - Practical challenges faced
 - User responses
 - Preliminary observations and outcomes

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9. Document implementation details using photographs, sketches, readings, and reports.

Exemplars and Utility:

Students may fabricate simple utility devices such as water-saving attachments, low-cost sanitation aids, ergonomic farm support tools, or waste handling mechanisms. They may also conduct structured audits to study household energy consumption, water usage patterns, maintenance condition of agricultural pumps, or waste management practices in the community. This activity helps students gain hands-on engineering experience and understand the practical challenges involved in implementing solutions in real environments. It improves technical skills, teamwork, project execution ability, troubleshooting capability, and documentation practices. The assignment also strengthens the connection between engineering knowledge and community-oriented problem solving through practical and sustainable interventions.

Experiment No.10	Community Awareness Program and Technology Demonstration	COs Mapped CO5	Hrs.
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Objective:

To develop students' ability to communicate engineering concepts and promote community awareness through technical demonstrations and user-oriented educational activities related to sustainable and safe engineering practices.

Associated Tasks:

1. Identify the topic for awareness activity or technology demonstration based on the selected intervention area.
2. Plan and organize a community awareness session or demonstration program.
3. Prepare awareness materials such as:
 - Posters
 - Charts
 - Leaflets
 - Presentation materials
 - Demonstration models
4. Explain technical concepts to community members in simple and understandable language.
5. Conduct demonstrations or discussions related to:
 - Water conservation
 - Sanitation and hygiene
 - Machine safety
 - Preventive maintenance
 - Fuel saving techniques
 - Waste segregation
 - Renewable energy usage
 - Ergonomic work practices
6. Interact with participants and respond to their questions and feedback.
7. Record:
 - Participant attendance
 - Community response
 - Observations and feedback
8. Document the activity with photographs, reports, and summary notes.

Exemplars and Utility:

Students may organize awareness programs on efficient water usage, safe handling of farm machinery, waste segregation methods, fuel-saving practices, or renewable energy applications in rural and urban communities. They may use posters, live demonstrations, simple charts, or prototype models to explain engineering concepts in an easy-to-understand manner. This activity helps students improve communication, leadership, teamwork, and public interaction skills while creating awareness among community members about sustainable and safe practices. It also strengthens students' confidence in presenting technical knowledge to non-technical audiences and highlights the social role of engineers in



community development and public welfare.

Experiment No.11	Impact Assessment, Feedback Collection and Sustainability Evaluation	COs Mapped CO5	Hrs.
Objective: To evaluate the effectiveness, usability, and sustainability of the implemented engineering intervention through user feedback, field observations, and impact assessment. Associated Tasks: 1. Conduct post-implementation observation of the developed solution or activity. 2. Interact with beneficiaries and collect user feedback regarding the intervention. 3. Evaluate the intervention based on: - Technical usefulness - Ease of operation - Time saving - Cost saving - Safety improvement - Environmental benefits - User acceptance and satisfaction 4. Compare conditions before and after implementation wherever applicable. 5. Record beneficiary suggestions, difficulties, and responses. 6. Analyze the sustainability and practicality of the intervention. 7. Prepare: - Feedback summary - Comparative observation notes - Impact assessment report - Short impact statement 8. Identify possibilities for: - Continued use - Replication in other areas - Future improvement or scaling Exemplars and Utility: Students may assess whether a water-saving attachment reduced water wastage, whether an ergonomic tool reduced physical effort, whether a waste segregation activity improved cleanliness practices, or whether an energy audit helped users reduce electricity consumption. Feedback may be collected from households, farmers, workers, or community representatives regarding ease of use, usefulness, and overall satisfaction. This activity helps students understand the real impact of engineering interventions on society and encourages evidence-based evaluation of solutions. It also develops assessment, analytical thinking, communication, and documentation skills while promoting sustainable and user-centered engineering practices with long-term community benefit.			
Experiment No.12	Final Documentation, Reflection and Project Presentation	COs Mapped CO5	Hrs.
Objective: To enable students to systematically document, present, and communicate the complete Community Engagement Project work carried out during the semester, including technical, social, and sustainability aspects of the project. Associated Tasks: 1. Compile all project activities and findings into a structured project report. 2. Prepare report sections including: - Community profile - Identified problem statement - SDG/UBA/UMA mapping - Technical analysis and diagnosis			



- Proposed engineering solution
- Implementation details
- Awareness activities conducted
- Impact assessment and feedback
- Reflective learning and conclusions
- 3. Organize field evidence such as:
 - Photographs
 - Observation records
 - Survey data
 - Technical sketches and drawings
- 4. Prepare presentation materials including:
 - Charts
 - Posters
 - PowerPoint slides
 - Demonstration models if applicable
- 5. Present the project before the departmental review panel.
- 6. Explain project objectives, methodology, implementation process, outcomes, and learning experiences.
- 7. Respond to questions and suggestions from reviewers.
- 8. Submit the final report and supporting documents in proper format.

Exemplars and Utility:

Students may prepare detailed reports documenting activities such as village surveys, resource mapping, technical audits, low-cost prototype development, awareness programs, and impact evaluation of engineering interventions. Presentation materials may include charts showing survey analysis, photographs of field activities, CAD drawings, implementation steps, and user feedback records. This activity helps students develop technical documentation, presentation, communication, and reporting skills. It also encourages reflective learning by helping students understand the social, technical, and sustainability aspects of community-based engineering projects. The assignment strengthens professional competency and prepares students for future project work, field engineering, and socially responsible engineering practice.

Suggested Community Engagement Themes for Mechanical Engineering Students (not limited to)

1. Low cost village water conservation devices
2. Solar crop dryer for rural households
3. Pedal operated grain cleaning or fodder cutting device
4. Smokeless biomass stove improvement
5. Foot operated handwash station
6. Household energy conservation audit
7. School sanitation utility design
8. Grey water reuse mechanism
9. Farm tool ergonomic redesign
10. Waste segregation trolley/bin design
11. Rainwater filter attachment
12. Women drudgery reduction mechanical aids
13. Panchayat/public building energy audit
14. Maintenance awareness of agricultural pumps
15. Rural composting support devices

Guidelines for Implementation

1. Students shall work in groups of 4 to 6.
2. Each group shall adopt one village/urban ward/slum cluster/institution/community under institute guidance.
3. Minimum four field visits shall be compulsory.



4. Every group shall identify at least three local problems and select one major engineering intervention theme.
5. Community participation and stakeholder approval shall be encouraged.
6. Students shall maintain field diary, photographs, survey records and mentor remarks.
7. Preference shall be given to projects aligned with UBA/UMA portals and SDG targets.
8. Institute may collaborate with Gram Panchayat, NGOs, schools, SHGs and local industries.

Textbooks:

1. Waterman, A. Service-Learning: A Guide to Planning, Implementing, and Assessing Student Projects. Routledge, 1997.
2. Beckman, M., and Long, J. F. Community-Based Research: Teaching for Community Impact. Stylus Publishing, 2016.
3. Design Thinking for Social Innovation. IDEO Press, 2015.
4. Dostilio, L. D., et al. The Community Engagement Professional's Guidebook: A Companion to The Community Engagement Professional in Higher Education. Stylus Publishing, 2017

Additional Learning Resources

1. Unnat Bharat Abhiyan official portal and village engagement manuals.
2. Unnat Maharashtra Abhiyan community development guidelines.
3. UNESCO – Education for Sustainable Development framework.
4. United Nations Sustainable Development Goals learning resources.
5. Rural Technology Action Group manuals.
6. Appropriate Technology and Frugal Innovation reference books.
7. Participatory Rural Appraisal manuals.

Virtual Lab, related open source/ subscription based software, Links or websites for lab conduction, animation, simulation etc., e-learning.

1. UNESCO: Education for Sustainable Development <https://www.unesco.org>
2. EPICS (Engineering Projects in Community Service) <https://engineering.purdue.edu/EPICS>
3. Ashoka: Innovators for the Public <https://www.ashoka.org>
4. Design for Change <https://www.dfeworld.com>
5. Community Engagement and Social Responsibility: https://onlinecourses.swayam2.ac.in/e-learning/preview/ugc26_ge01
6. Education for Sustainable Development (ESD): <https://www.unesco.org/en/sustainable-development/education>
7. UN Sustainable Development Information Portal: <https://www.un.org/sustainabledevelopment/>
8. Centre for Technology Alternatives for Rural Areas, C-TARA, IIT Bombay, <https://www.ctara.iitb.ac.in/>
9. Unnat Bharat Abhiyan: <https://unnatbharatabhiyan.gov.in/>

CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	1	1	1	3	2	2	3	3	1	1	1	1
CO2	2	3	2	3	1	3	3	2	2	2	1	1	1	1
CO3	1	2	1	2	1	3	3	2	2	2	1	1	1	2
CO4	3	3	3	3	2	2	2	2	3	2	2	3	3	2
CO5	2	2	2	3	2	3	3	3	3	3	2	2	2	2
Avg.	2.0	2.4	1.8	2.4	1.4	2.8	2.6	2.2	2.6	2.4	1.4	1.6	1.6	1.6

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

(Signature)

(Signature)



Assessment Pattern

BT Level	CCE based on ARCV											
	Exp. 1	Exp. 2	Exp. 3	Exp. 4	Exp. 5	Exp. 6	Exp. 7	Exp. 8	Exp. 9	Exp. 10	Exp. 11	Exp. 12
CO	CO1	CO2	CO2	CO2	CO3	CO4	CO4	CO4	CO5	CO5	CO5	CO5
L1												
L2	1											
L3	1	2	2									
L4		2	2	2	3							
L5									3	3	3	3
L6						3	3	3	2			

This course serves as a prerequisite for / maps with the following future courses:
This course shall help the student in understanding the process of Project Based Learning (PBL) and will be pre-requisite for mini/micro and course project.

Job Mapping:

Job opportunities that one can get after learning this course:

1. Field engineering,
2. Sustainability,
3. Project execution,
4. Technical survey,
5. Community interaction,
6. Social innovation,
7. Smart infrastructure support,
8. Grassroots technology deployment.

Amrutvahini

R. Gaurav



SEMESTER - IV

Amrutvahini

R. G. Gaurav



Program:	S. Y. B. Tech				Semester:		IV	
Course:	Manufacturing Processes-1				Course Code:		R25-ME-PCC-211	
Teaching Scheme				Examination Scheme				
Lecture	Practical	Tutorial	Credit	CCE	ESE	TW	PR	
03Hrs/Week	--	--	3	40	60	--	--	

Course Description and Relevance:

This course provides a comprehensive understanding of conventional manufacturing processes with emphasis on machining, casting, metal forming, joining, grinding, and finishing operations. The course develops the ability to correlate process parameters, tooling, material behavior, and product quality requirements in modern manufacturing environments.

Learners gain practical exposure to process selection, force and power estimation, defect analysis, tooling design, and surface integrity requirements relevant to automotive, aerospace, tooling, heavy engineering, and precision manufacturing industries.

Prerequisite:

Engineering Workshop Skills Lab
Material Science and Metallurgy
Engineering Physics

Bridge Content:

Understanding the transformation of raw materials into finished products using conventional manufacturing processes.

Course Objectives:

1. To know fundamentals of metal cutting process, tool wear and tool life
2. To describe various casting methods and mould design aspects
3. To understand basics of metal forming processes and tooling
4. To classify and explain principles of welding techniques
5. To explain grinding and advanced finishing processes

Course Outcomes: After learning the course, students will be able to

CO	Course Outcome	Bloom's Level
CO1	EXPLAIN metal cutting mechanics and tool wear analysis for machining performance improvement.	2
CO2	EXPLAIN gating systems and casting defects with suitable remedies.	2
CO3	COMPUTE forces, power, and deformation behavior in metal forming processes.	3
CO4	SELECT welding techniques based on welding defects and process requirements.	3
CO5	SELECT appropriate grinding and fine finishing processes based on surface quality requirements.	3

Course Content

Unit 1	Theory of Metal Cutting	8 Hrs.	COs Mapped CO1
Basic principles of metal cutting, mechanics of chip formation, types of chips (continuous, discontinuous and built-up edge), orthogonal and oblique cutting systems, Merchant's circle analysis for force relationships, shear angle and friction effects in machining, estimation of cutting forces, machining power and specific cutting energy, cutting temperature and its effect on tool life, cutting tool materials, ISO tool signature and tool geometry, functions of cutting fluids, mechanisms of tool wear (crater and flank wear), tool failure criteria, and Taylor's tool life equation for process optimization.			

Exemplars / Practical Applications and usage:

Automotive and aerospace machining, tool and die manufacturing, medical device manufacturing.



Unit 2	Metal Casting Technology	8 Hrs.	COs Mapped CO2
Pattern materials and pattern design, pattern allowances, moulding sand composition, properties and testing, core making processes, melting furnaces and molten metal handling practices, gating system design principles including pouring basin, sprue, runner and ingate design, riser design and solidification control, cleaning and fettling operations, casting defects with causes, remedies and quality control methods, and special casting processes such as die casting, centrifugal casting, investment casting, shell moulding, and continuous casting.			
Exemplars / Practical Applications and usage: Foundry industries, engine block manufacturing, heavy equipment and casting industries.			
Unit 3	Metal Forming Technology	8 Hrs.	COs Mapped CO3
Fundamentals of plastic deformation and stress-strain relationships in metal forming, rolling process classifications, rolling defects, roll separating force and power calculations, forging operations and die types, estimation of forging load and energy, extrusion and drawing basics, sheet metal cutting and forming operations such as blanking, piercing, bending and deep drawing, strip layout design, punch and die clearance, center of pressure calculations, and press capacity selection.			
Exemplars / Practical Applications and usage: Automotive forming processes, rolling mills, electronics and appliance industries.			
Unit 4	Joining Technology	8 Hrs.	COs Mapped CO4
Welding terminology, welding symbols and standard joint configurations, selection of electrodes and flux coatings, heat affected zone and metallurgical effects of welding, welding defects and non-destructive inspection methods, arc welding processes including SMAW, MIG and TIG, resistance welding processes such as spot and seam welding, oxy-acetylene gas welding, basics of brazing and soldering, solid-state joining methods including friction welding and diffusion bonding, advanced welding processes such as laser beam welding, electron beam welding, plasma arc welding, and ultrasonic welding, and selection of appropriate welding processes for industrial applications.			
Exemplars / Practical Applications and usage: Automotive assembly, shipbuilding and aerospace, construction and fabrication.			
Unit 5	Finishing and Fine Finishing Processes	8 Hrs.	Cos Mapped CO5
Principles of grinding, types of grinding machines, grinding wheel specifications and selection, wheel wear, dressing and truing, wheel balancing, grinding parameters and time estimation, measurement of surface roughness and dimensional accuracy, honing, lapping, superfinishing, polishing and buffing, magnetic abrasive finishing, ultrasonic machining-based finishing, abrasive flow machining, and finishing process selection based on tolerance and surface integrity requirements.			
Exemplars / Practical Applications and usage: Tool and die finishing, aerospace and medical polishing, semiconductor processing.			
Comprehensive Continuous Evaluation (CCE) components for the course:			
1) Course Projects (Mini/Micro Project): Mini project based on machining, casting, metal forming, welding, or finishing process applications, including process analysis, design calculations, defect analysis, or manufacturing process optimization.			
2) Class Tests / Unit Tests: CT1: Unit I and Unit II			



3) Assignments: Numerical problems, process analysis, industrial case studies, and design-based assignments related to manufacturing processes.

4) Field Activity / Case Study: Industrial visit report, process observation, defect analysis, or case study on manufacturing industries such as machining, casting, welding, or forming industries.

5) Quiz / Presentation: Technical quiz, seminar, or presentation on advanced manufacturing technologies, tooling, welding methods, or sustainable manufacturing practices.

Textbooks:

1. P. N. Rao, Manufacturing Technology – Vol. I & II, Tata McGraw Hill Publications.
2. P. C. Sharma, Production Engineering, S. Chand Publications.
3. P. N. Rao, Manufacturing Technology – Metal Cutting and Machine Tools, Tata McGraw Hill Publications.
4. P. C. Sharma, A Textbook of Production Engineering, S. Chand Publications.
5. B. S. Raghuwanshi, Workshop Technology – Vol. I & II, Dhanpat Rai Publications.
6. Amitabha Ghosh and Ashok Kumar Mallik, Manufacturing Science, East-West Press.
7. S. K. Hajra Choudhury, A. K. Hajra Choudhury and Nirjhar Roy, Elements of Workshop Technology – Vol. I & II, Media Promoters & Publishers Pvt. Ltd.

Reference Books:

1. W. A. J. Chapman, Workshop Technology – Vol. I & II, CBS Publishers.
2. R. K. Jain, Production Technology, Khanna Publishers.
3. B. L. Juneja, G. S. Sekhon and Nitin Seth, Fundamentals of Metal Cutting and Machine Tools, New Age International Publishers.
4. R. S. Parmar, Welding Engineering, Khanna Publishers.
5. P. C. Pandey and H. S. Shan, Modern Machining Processes, Tata McGraw Hill Publications.
6. Mikell P. Groover, Fundamentals of Modern Manufacturing, Wiley India Publications.
7. Degarmo, Black and Kohser, Materials and Processes in Manufacturing, Wiley Publications.

MOOCs Links and additional reading material:

1. <https://youtu.be/JpQHtQm-wBo?list=PLFW6lRTa1g811vIFgNhj-NLhUONoxvnpn>
2. https://youtu.be/TBzKT7_fY2c?list=PLSGws_74K01_WAP4lwiDf7jQVCndMi2
3. <https://youtu.be/yGKym19qxiM?list=PLNbED5J9RQDHCqDUslQHZZdkPov0rpdf>
4. <https://youtu.be/mmKy5PbndQI?list=PLyqSpQzTE6M-KwjFQByBvRx464XpCgOEC>
5. https://www.youtube.com/watch?v=NI8M6p_ziyc&list=PLwdnzlV3ogoWHK0muG5V32yd3K_5aFS4X

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	-	-	-	-	-	3	2	1
CO2	3	3	3	2	2	-	-	-	-	-	-	3	2	1
CO3	3	2	2	2	2	-	-	-	-	-	-	3	3	1
CO4	3	3	2	2	2	1	-	-	-	-	-	2	3	2
CO5	2	3	2	2	3	-	1	1	-	-	-	2	3	2
Avg.	2.8	2.8	2.2	2.0	2.2	0.2	0.2	0.2	0	0	0	2.6	2.6	1.4

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

(Signature)

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Unit wise Weightage:

Exam	Unit1	Unit 2	Unit 3	Unit 4	Unit 5
CT1	CO- 1&2		-	-	-
CCE Assessment by Teacher	8 Unit Test	8 Unit Test	8 Quiz	8 Presentation	8 Industrial Visit Report
ESE	12	12	12	12	12
Total	20	20	20	20	20

Assessment Pattern

BT Level	CCE						ESE				
	CT1	CCE2	CCE3	CCE4			CO1	CO2	CO3	CO4	CO5
CO	CO 1&2										
L1	-	-	-	-			-	-	-	-	-
L2	8	4	-	-			6	6	6	6	6
L3	8	4	-	8			6	6	6	6	6
L4	-	-	8	-			-	-	-	-	-
L5	-	-	-	-			-	-	-	-	-
L6	-	-	-	-			-	-	-	-	-

This course serves as a prerequisite for / maps with the following future courses:

1. Manufacturing Processes–II
2. Advanced Manufacturing Processes
3. Industrial Engineering
4. Production and Operations Management

Job Mapping:

Job opportunities that one can get after learning this course:

1. Manufacturing Engineer
2. Welding Engineer / Welding Inspector
3. Shop Floor Supervisor

Signature

Signature



Program:		S. Y. B. Tech (Mechanical Engineering)			Semester:		IV	
Course:		Fluid mechanics			Course Code:		R25-ME-PCC-212	
Teaching Scheme				Examination Scheme				
Lecture	Practical	Tutorial	Credit	CCE	ESE	TW	PR	
03	--	-	3	40	60	--	--	
Course Description and Relevance: Fluid Mechanics is the branch of physics and engineering that studies the behavior of fluids (liquids, gases, and plasmas) at rest and in motion. It encompasses fundamental principles such as fluid statics (pressure distribution, buoyancy), fluid kinematics (description of motion without considering forces), and fluid dynamics (analysis of forces, energy, and momentum in flowing fluids). Core concepts include conservation of mass, momentum (Navier-Stokes equations), and energy, as well as phenomena like laminar and turbulent flow, boundary layers, drag, lift, and flow through pipes and channels. The course bridges theoretical analysis with experimental methods and computational simulations, providing a systematic framework to predict and control fluid behavior in engineering systems. Fluid Mechanics is essential because fluids are all over in nature and technology—from blood flow in the human body and weather patterns in the atmosphere to water distribution networks and aircraft aerodynamics. It directly underpins the design and optimization of countless engineering applications: pipelines, pumps and turbines, HVAC systems, automotive and aerospace vehicles, ship hulls, chemical reactors, and renewable energy systems like wind and hydroelectric power. Without fluid mechanics, it would be impossible to safely design oil and gas pipelines, predict flood risks, reduce vehicle fuel consumption, improve medical devices (e.g., artificial heart valves), or scale up industrial processes. Mastery of this subject equips engineers and scientists to solve real-world problems involving efficiency, safety, and sustainability—making it a cornerstone discipline in mechanical, civil, chemical, biomedical, and environmental engineering.-								
Prerequisite: 1. Physics (Classical Mechanics) 2. Mathematics (Calculus & Differential Equations) 3. Thermodynamics 4. Statics and Dynamics (Engineering Mechanics) 5. Applied Mathematics								
Bridge Content: Not required								
Course Objectives: 1. Understand and apply fundamental fluid properties and statics 2. Apply conservation laws to fluid systems and control volumes, Select and interpret flow measurement devices 3. Analyze internal flows in pipes and differentiate between laminar and turbulent flow regimes 4. Explore Boundary layer theory and analyze external flows and lift generation 5. Perform dimensional analysis and similitude								
Course Outcomes: After learning the course, students will be able to								
CO	Course Outcome						Bloom's Level	
CO1	COMPUTE fundamental properties and hydrostatic forces on submerged plane and curved surfaces, and analyze the stability of floating and submerged bodies.						3	
CO2	APPLY integral forms of conservation laws (mass, momentum, and energy) using the Bernoulli's theorem						3	
CO3	DIFFERENTIATE between laminar and turbulent flow regimes by calculating Reynolds numbers, and ESTIMATE frictional head losses in pipe flow systems using the Darcy-Weisbach equation, Moody chart, and minor loss coefficients.						3	
CO4	CALCULATE drag and lift forces on immersed bodies (spheres, cylinders, airfoils) by interpreting boundary layer behavior, pressure distributions, and empirical drag coefficient correlations for both streamlined and bluff bodies.						3	
CO5	PERFORM dimensional analysis using the Buckingham Pi theorem to derive						3	



	dimensionless parameters (Reynolds, Froude, Euler numbers) and APPLY similitude principles to scale model experiments to prototype conditions		
Course Content			
Unit 1	Fundamentals of Principles and Statics	8 Hrs.	COs Mapped CO1
Fluid Properties & Fundamentals: Definition of fluids, continuum hypothesis, density, specific weight, specific gravity, viscosity (including laws), fluid classification & rheology, vapor pressure, surface tension, capillarity, and compressibility. Fluid Statics: Forces on fluid elements, Pascal's law, hydrostatic law. Pressure measurement scales and devices: piezometer, barometer, simple/inclined/differential/micro manometers, and inverted manometers. Hydrostatic Forces & Buoyancy: Total pressure and centre of pressure on submerged plane and curved surfaces. Buoyancy, flotation, and stability of immersed bodies.			
Exemplars Lubrication oil, bearings, detergent powder, dam construction, ship design			
Unit 2	Fluid Kinematics & Dynamics	8 Hrs.	COs Mapped CO2
Description of Fluid Motion Lagrangian vs. Eulerian descriptions; velocity and acceleration fields; steady and unsteady flow; uniform and non-uniform flow; one-, two-, and three-dimensional flows. Flow Visualization Streamlines, pathlines, streaklines, and streamtubes. Potential function and stream function, flow net Derivation of Euler's equation of motion along a streamline for inviscid flow. Derivation, assumptions, and physical interpretation; Bernoulli's equation for steady, incompressible, inviscid flow along a streamline. Pitot tube, Venturi meter, orifice meter, orifices, notches Energy grade line (EGL) and hydraulic grade line (HGL);			
Exemplars / Practical Applications and usage: Venturimeter in Agriculture, in carburetor.			
Unit 3	Internal Flow	8 Hrs.	COs Mapped CO3
Laminar flow: Velocity profile in fully developed laminar pipe flow; friction factor relation Turbulent Pipe Flow: velocity profiles (power law, log-law); Reynolds stresses; friction factor: Moody chart Head Losses; Major losses (Darcy-Weisbach equation); minor losses (inlets, exits, bends, expansions, contractions, valves) Pipe Networks: Series and parallel pipe systems; branching pipes; equivalent length method. siphon. Power transmission			
Exemplars / Practical Applications and usage: Medical: Blood flow in capillaries, Chimney design: Flue gas velocity profile affects.			
Unit 4	External Flow	8 Hrs.	COs Mapped CO4
Boundary Layer Concept: No-slip condition; boundary layer development over a flat plate; displacement, momentum, and energy thicknesses. Flow Separation: Adverse pressure gradient; separation point; wake formation and pressure drag and methods to control separation Drag and Lift on Bodies: Drag coefficient (pressure drag + skin friction); streamlining; lift coefficient; airfoil theory, types of drag, drag & lift coefficient, aerodynamics			
Exemplars / Practical Applications and usage: Aircraft fuselage, Wind turbine blades, Heat transfer estimation, Car rear windshield			
Unit 5	Dimensional Analysis & Similitude	8 Hrs.	COs Mapped CO5



Dimensions and Units: Primary dimensions (M, L, T, θ); secondary dimensions; dimensional homogeneity. Buckingham Pi Theorem: Statement and proof concept; method of repeating variables; determination of Pi terms.

Dimensionless Parameters: Reynolds, Froude, Euler, Mach, Weber, Strouhal numbers; physical significance of each.

Similitude: Geometric, kinematic, and dynamic similarity; scaling laws; model testing and extrapolation to prototypes; distortion in models.

Exemplars / Practical Applications and usage:

Turbine model, wind tunnel model test, irrigation system, dam model analysis

Comprehensive Continuous Evaluation (CCE) components for the course:

Continuous Internal Assessment (Quizzes, Tutorials) Students are encouraged to undertake a course Quiz, power point presentation, Tutorials that enables them to apply the foundational knowledge gained in design engineering, fluid systems

Course Project:

The module can take various forms, such as a physical or digital prototype, virtual simulation, data analysis, comparative study of different mechanical systems, or research-based work. Additionally, students are encouraged to explore the application of emerging technologies like Artificial Intelligence (AI), the Internet of Things (IoT), and automation within mechanical systems, promoting innovation and interdisciplinary learning.

Real World Assignment

1. Comparative analysis of detergents in context with surface tension and preparation of effective alternative powder with additives.
2. Calculate the total force on the walls of a dam or water reservoir/tank due to fluid pressure. Also draw pressure variation w.r.t depth of water level: A case study.
3. Design ship using principle of Buoyancy and floatation: A case study.
4. Design/calculate forces acting on a hydraulic Jack using Pascal's Law: A case study
5. Calibrate a Venturi meter in the laboratory and compare experimental discharge coefficients with theoretical values.
6. Analyze a given pipe network (series/parallel) for flow distribution and head loss – a case study.
7. Estimate boundary layer thickness over a flat plate in a water channel or wind tunnel.
8. Apply Reynolds number similarity to design a miniature wind turbine for testing before manufacturing full-scale blades.

1. **Class Tests / Unit Tests:** Unit 1 and Unit2. (20Marks)

2. **Course Projects:** Unit 3, and Unit 4. (10 Marks)

Course Projects should be framed based on real-world problems relevant to the subject. Each course project must be communicated through one of the following modes. It is recommended to complete all the communication modes across different course projects:

- Poster Presentation
- PowerPoint Presentation
- Model Making
- Field or Survey Report with Oral Presentation (e.g., case study)
- Submission of Digital Content (e.g. Video Summary)

3. **Assignments / Case Study:** Unit3, Unit 4 (10 Marks)

Students should submit one assignment or one Case Study Report based on Unit 3 and one assignment or one Case Study Report based on Unit 4.

– **Format:** Problem-solving tasks, theoretical questions, practical exercises, or case studies that require in-depth analysis and application of concepts.

Textbooks:

1. Frank M. White *Fluid Mechanics* (8th or 9th Edition)
2. Donald F. Elger, Clayton T. Crowe, et al. *Engineering Fluid Mechanics* (11th Edition)



3. Sukumar Pati, —Fluid Mechanics and Hydraulics Machines, TATA McGraw Hill.
4. Munson, Young and Okiishi, —Fundamentals of Fluid Mechanics, Wiley India
5. Potter Wiggert, —Fluid Mechanics, Cengage Learning
6. Fox, Pichard, —Introduction to Fluid Mechanics, McDonald- Wiley
7. Modi P. N. and Seth S. M, —Hydraulics and Fluid Mechanics, Standard Book House

Reference Books:

1. Yunus A. Çengel & John M. Cimbala *Fluid Mechanics: Fundamentals and Applications* (4th Edition)
2. Robert W. Fox, Alan T. McDonald, Philip J. Pritchard *introduction to Fluid Mechanics* (8th Edition)
3. R.K. Bansal *Fluid Mechanics and Hydraulic Machines*
4. Hermann Schlichting *Boundary Layer Theory* (8th Edition)

MOOCs Links and additional reading material:

1. <https://archive.nptel.ac.in/courses/112/104/112104118/#> Fundamental of Fluid Mechanics
2. <https://archive.nptel.ac.in/courses/112/105/112105269/> Fluid Statics
3. <https://archive.nptel.ac.in/courses/112/105/112105171/> Fluid Kinematics
4. nptel.ac.in/courses/112104118 Bernoulli's Equation
5. nptel.ac.in/courses/112104118 Viscous flow
6. nptel.ac.in/courses/112104118 Boundary Layer Formation

CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	3	1	-	-	-	-		2	
CO2	3	3	1	1	2	3	1	-	-	-	-		2	-
CO3	2	3	1	1	2	3	1	-	-	-	-		2	
CO4	2	2	1	2	2	3	1	-	-	-	-		2	
CO5	3	3	1	1	2	3	1	-	-	-	-		2	
Avg.	3	3	1	1	2	3	1	-	-	-	-		2	

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Unit wise Weightage:

Exam	Unit1	Unit2	Unit3	Unit4	Unit5
CCE					
CT1	10	10			
Assignment			5	5	
Course Project			5	5	
ESE	10	10	10	10	20
Total	20	20	20	20	20

Assessment Pattern

BT Level	CCE						ESE				
	CT1		CCE2		CCE3						
CO	CO1	CO2	CO3	CO4	CO3	CO4	CO1	CO2	CO3	CO4	CO5
L1											
L2	5	5	5	5	5	5					
L3	5	5	5	5	5	5	05	05	05	05	05
L4							05	05	05	05	05
L5											10
L6											



This course serves as a prerequisite for / maps with the following future courses:

Heat Transfer, Turbo Machinery, Aerodynamics, Gas Dynamics, CFD, Hydraulic Engineering, Biomechanics

Job Mapping:

1. Aerospace & Défense
2. Automotive & Motorsports
3. Energy & Power Generation
4. Oil, Gas & Petrochemicals
5. Civil & Environmental Engineering
6. HVAC & Building Services
7. Biomedical & Healthcare
8. Marine & Offshore
9. Consumer Goods & Industrial Design
10. Consulting & Software



Program:		S. Y. B. Tech		Semester:		IV	
Course:		Applied Thermodynamics			Course Code:		R-25-MEPCC-213
Teaching Scheme				Examination Scheme			
Lecture	Practical	Tutorial	Credit	CCE	ESE	TW	PR
03	--	--	3	40	60	--	--
Course Description and Relevance: This course focuses on the principles, operation, and performance analysis of internal combustion (IC) engines. It covers air-standard, fuel-air, and actual engine cycles, along with detailed study of combustion processes in spark ignition (SI) and compression ignition (CI) engines. The course also introduces fuel technologies, including alternative and sustainable fuels, and examines their impact on engine performance and emissions. Further, the course emphasizes experimental evaluation of engine performance through testing methods, analysis of characteristic curves, and preparation of heat balance sheets. It also includes emission control technologies and regulatory standards. In addition, students gain knowledge of engine subsystems such as ignition, cooling, and lubrication, along with exposure to modern advancements like electronic engine management systems, AI-based diagnostics, and emerging combustion technologies. This course provides fundamental knowledge of IC engines, energy conversion, combustion, and performance evaluation essential for automotive and power generation applications. It supports efficient and sustainable system design by addressing fuel technologies and emission control. It also forms a foundation for advanced studies in thermal, automobile, and energy engineering.							
Prerequisite: Systems in Mechanical Engineering, Basics of Engineering Thermodynamics, Engineering Chemistry & Engineering Mathematics.							
Bridge Content: This course bridges fundamental concepts from basic thermodynamics, engineering mechanics, and fluid mechanics to their practical application in internal combustion engines. It reinforces prior knowledge of energy conversion, properties of working fluids, and heat transfer while introducing real-world engine systems, combustion processes, and performance evaluation techniques. It also develops analytical thinking by connecting theoretical principles with modern engine technologies and applications.							
Course Objectives: 1. To study working of engine, actual, fuel-air and air standard cycle and its performance. 2. To understand combustion in si engine and factors affecting performance parameters. 3. To understand combustion in ci engine and factors affecting performance parameters. 4. To estimate performance parameters by conducting a test on i. c. engines. 5. To understand the functions of ignition, cooling, and lubrication systems, along with advanced IC engine technologies							
Course Outcomes: After learning the course, students will be able to							
CO	Course Outcome						Bloom's Level
CO1	UNDERSTAND the working principles of IC engines, the effects of fuel-air and actual cycles on engine performance, and the impact of cycle losses.						2
CO2	ASSESS the combustion characteristics in SI engines and the influence of fuel properties on knocking.						3
CO3	ASSESS the suitability of alternative fuels for improved efficiency and emissions.						3
CO4	ANALYZE engine performance through engine testing, interpretation of characteristic curves, and emission control techniques.						4
CO5	INVESTIGATE the functions of ignition, cooling, and lubrication systems, along with advanced IC engine technologies.						3
Course Content							
Unit 1	Fundamentals of IC Engines & Air, Fuel, and Actual Engine Cycles				7 Hrs.	CO Mapped CO1	



Fundamentals of IC Engines: Heat Engine, Engine classification, Applications, I.C. Engine construction, components and materials, Engine nomenclature, Valve timing diagram, Intake and exhaust system.

Air, Fuel and Actual Cycle: Air-standard cycles- Otto, Diesel & Dual Cycle (Derivation of Efficiencies & MEP), fuel air cycles, and actual cycles, Effects of variables on performance, various losses and Comparison of Air standard with Fuel and Actual cycle. (Numerical on Air-standard cycles)

Exemplars / Practical Applications and usage:

Used in different engine types for efficiency optimization in vehicles, power plants, and Automotive industrial engines.

Unit 2	Fundamentals of SI Engine and Fuel Technology	7 Hrs.	CO Mapped CO2
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Theory of Carburetion and Types of Carburetors, Working of Simple Carburetor, Electronic Fuel Injection System, Combustion in SI engine, factors affecting efficiency, Knocking in SI engine, Rating of fuels in SI engines Combustion Chambers used in SI engine.

Fuel Technology: Hydrogen, synthetic fuels, LPG, CNG, ethanol blends. Role of octane number, fuel additives.

Usage: Diagnosing knocking issues in petrol vehicles; selecting appropriate fuel octane rating for different engines; understanding modern EFI systems in two-wheelers and four-wheelers.

Exemplars: Study of a carburetor vs. EFI system; case study on the effect of fuel octane number on engine performance; identification of combustion chamber types in different engines.

Unit 3	Fundamentals of CI Engine and Fuel Technology	7 Hrs.	CO Mapped CO3
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Fuel Injection system, Construction and Working of Fuel Pump, Fuel Injector and Various types of Nozzle, Combustion in CI engine, factors affecting efficiency, Knocking in CI engines, Rating of fuels in CI engines, Combustion Chambers used in CI engine.

Fuel Technology: Biofuels, Biofuel-Diesel Blends, Flex Fuels and Technology. Role of Cetane number, fuel additives.

Exemplars / Practical Applications and usage:

Usage: Diagnosing diesel knock in heavy vehicles and generators; selecting appropriate cetane rating fuels; understanding CRDi (Common Rail Direct Injection) systems.

Exemplars: Study of a fuel injector and nozzle types; case study on the effect of fuel cetane number on cold starting and knocking; comparison of direct vs. indirect injection combustion chambers

Unit 4	Engine Performance & Testing, Emission Control Technologies	7 Hrs.	CO Mapped CO4
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Engine Testing Procedure and Engine parameters, Measurement of indicated power, Brake power, fuel consumption, Air Consumption, Measurement of friction power by Willan's Line Method and Morse Test, calculation of mean effective pressure, various efficiencies, specific fuel consumption, heat balance sheet of IC Engines and performance Characteristic curves. (Numerical on Engine parameters & HBS). Role of supercharging and turbocharging in engine performance improvement. Emission Control Technologies: Pollutants from engines- CO, HC, NOx, PM, and their impact on air quality,

Emission reduction strategies: Exhaust Gas Recirculation (EGR), Selective Catalytic Reduction (SCR), Diesel Particulate Filters (DPF), Three-Way Catalysts (TWC), BS-VI and Euro 6 emission standards

Exemplars / Practical Applications and usage:

Exemplars: Morse Test on a multi-cylinder petrol engine; Heat Balance Sheet on a diesel engine generator; analyzing emission test reports from a PUC (Pollution Under Control) center; study of turbocharger vs. supercharger.

Applications and usage The selection of IC Engines according to their specifications and performance for different applications such as automotive, aviation, power generation, marine, and industrial machinery.

2. Used in Power generation, construction, and marine sectors have adopted DPF, TWC, and BS VI/Euro 6 emission standards to meet stringent environmental regulations.

Unit 5	Engine Systems & Recent Trends in I.C Engine	7 Hrs.	CO Mapped
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CO5														
Ignition system: Battery coil ignition system, magneto ignition system, Electronics Ignition (CDI- Capacitor Discharge Igniter, TCI-Transistor Controlled Igniter). Cooling system: Air Cooling, Liquid cooling. Lubrication system: Objectives of lubrication system, properties of lubricant, Methods of lubrication system, Recent Trends in IC Engine: Introduction to engine management systems (EMS) and ECU-controlled ignition, Advanced combustion technologies: HCCI (Homogeneous Charge Compression Ignition), AI based predictive maintenance, fault diagnosis, and digital twins in IC engines..														
Exemplars / Practical Applications and usage: Automotive Industry – Used in cars, trucks, and buses for fuel efficiency, emissions control, and performance optimization.														
Comprehensive Continuous Evaluation (CCE) components for the course:														
1. Unit test on Unit 1 and Unit 4 2. Assignment on unit 2 3. Poster presentation on Unit 3 4. Industrial/Field Visit Report on Unit 5														
Textbooks:														
1. V. Ganesan, “Internal Combustion Engines”, Tata McGraw-Hill 2. M. L. Mathur and R.P. Sharma, “A course in Internal combustion engines”, Dhanpat Rai & Co. 3. H.N. Gupta, “Fundamentals of Internal Combustion Engines”, PHI Learning Pvt. Ltd.														
Reference Books:														
1. Heywood, “Internal Combustion Engine Fundamentals”, Tata McGraw-Hill 2. Domkundwar & Domkundwar, “Internal Combustion Engine”, Dhanpat Rai & Co. 3. R. Yadav, “Internal Combustion Engine”, Central Book Depot, Ahmedabad. 4. S. Domkundwar, C.P. Kothandaraman, A. Domkundwar, “Thermal Engineering”, Dhanpat Rai														
MOOCs Links and additional reading material:														
Fundamentals of IC Engines • https://www.digimat.in/nptel/courses/video/112103262/112103262.html • https://ocw.mit.edu/courses/2-61-internal-combustion-engines-spring-2017/ SI Engine • https://onlinecourses-archive.nptel.ac.in/noc18_ae04/course • https://onlinecourses.nptel.ac.in CI Engine • https://www.digimat.in/nptel/courses/video/112103262/112103262.html • https://onlinecourses-archive.nptel.ac.in/noc18_ae04/course Engine Testing • https://onlinecourses.nptel.ac.in/noc25_me19/preview • https://ocw.mit.edu/courses/2-61-internal-combustion-engines-spring-2017/ Engine Systems • https://www.edx.org/learn/automotive-engineering • https://ocw.mit.edu/courses/2-61-internal-combustion-engines-spring-2017/														

CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1	2	1	0	1	0	0	0	1	2	2	0
CO2	3	3	1	2	1	0	1	0	0	0	1	2	2	0
CO3	3	3	2	2	1	1	3	0	0	0	1	2	3	0
CO4	3	3	2	3	2	1	3	0	1	1	2	3	3	1
CO5	3	2	2	2	2	1	2	0	1	1	2	3	2	1
Avg.	3	2.8	1.6	2.2	1.4	0.6	2	0	0.4	0.4	1.4	2.4	2.4	0.4



1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Unit wise Weightage:

Exam	Unit1	Unit2	Unit3	Unit4	Unit5
CCE					
CT1	8			8	
Assignment		8			
Poster			8		
Field Visit					8
ESE	12	12	12	12	12
Total	20	20	20	20	20

Assessment Pattern

BT Level	ESE									
	CT1	CCE2	CCE3	CCE4						
CO	CO1, CO4	CO2	CO3	CO5	CO1	CO2	CO3	CO4	CO5	
L1	8	-	-	-	6	6	6	-	6	
L2	8	8	8	8	6	6	6	6	6	
L3	-		-	-	-		-	6	-	
L4	-	-	-	-	-	-	-	-	-	
L5	-	-	-		-	-	-	-	-	

This course serves as a prerequisite for / maps with the following future courses:

1. Advanced Internal Combustion Engines
2. Automobile Engineering
3. Refrigeration and Air Conditioning
4. Power Plant Engineering
5. Energy Engineering / Renewable Energy Systems
6. Computational Fluid Dynamics (CFD)
7. Mechatronics / Automotive Electronics

Job Mapping:

Job opportunities that one can get after learning this course:

Automotive, thermal, energy, and allied industries.
Maintenance & Plant Engineer.



	microcontroller and PLC platforms using Ziegler-Nichols and classical tuning methods.	
CO5	EXPLAIN PLC ladder logic programs incorporating timers, counters, and logic gates for automating industrial control sequences in hydraulic, pneumatic, and mechatronic systems.	2
Course Content		
Unit 1	Sensors and Actuators	COs Mapped: CO1
Introduction to Sensors: Characteristics: sensitivity, range, accuracy, resolution, linearity. Types: Active vs. Passive, Analog vs. Digital. Modern Sensor Technologies: MEMS sensors, Optical sensors (LiDAR, IR, UV). Piezoelectric, Proximity sensor (Capacitive, Inductive and optical sensors). Gyroscopes, Accelerometers, Magnetometers (IMU), encoder, LDR, Smart Sensors Actuators: Pneumatic, Hydraulic, Electrical actuators. Servo motors, Stepper motors, DC/AC motors. Piezoelectric actuators, Electrohydraulic and Electropneumatic systems. Exemplars / Practical Applications and usage: Calibration of temperature, proximity and MEMS sensors. Stepper and servo motor characterisation. Sensor fusion in IMUs for robotics, drones, and wearable devices. Industrial pick-and-place robots with pneumatic grippers.		
Unit 2	Data Acquisition and Signal Communication Systems	COs Mapped: CO2
Data Acquisition Systems (DAQ): Architecture: sensors to signal conditioning to ADC to processing. Sampling theorem, Nyquist criterion, Aliasing. Signal Conditioning: Amplification, Filtering (low-pass, high-pass, band-pass). Bridge circuits, Instrumentation amplifiers. Analog-to-Digital Convertor Digital-to-Analog convertor Exemplars / Practical Applications and usage: Design of a DAQ chain from thermocouple to MATLAB. RC low-pass filter verification on oscilloscope.		
Unit 3	Control Systems	COs Mapped: CO3
Transfer Function Modelling: Deriving TF of mechanical, electrical, electromechanical systems. Block diagram algebra. Time-Domain Analysis: Standard test signals: step, ramp, impulse, sinusoidal. Transient response: rise time, settling time, overshoot, steady-state error. First and second-order system response. Frequency-Domain: Bode plots, Gain margin, Phase margin. Exemplars / Practical Applications and usage: DC motor transfer function derivation and MATLAB step response verification. First and second-order system simulation in Simulink. Bode plot and stability margin analysis. Routh-Hurwitz stability check for a third-order system. State-space modelling of a mass-spring-damper system		
Unit 4	Controllers	COs Mapped: CO4
Classical Controllers: P, PI, PD, PID controller design and tuning. Ziegler-Nichols, Feedback, Feed-forward and Cascade. Digital Controllers: Discrete-time systems, Digital PID. PLC programming basics (Ladder, Function Block). Exemplars / Practical Applications and usage: Manual PID tuning on Arduino-controlled DC motor. Ziegler-Nichols closed-loop tuning experiment. Digital PID implementation in MATLAB/Simulink. PLC ladder logic for start/stop motor control. Raspberry Pi real-time PID control via Simulink Embedded Coder).		
Unit 5	Programmable Logic Controller	COs Mapped: CO5
6 Hrs		



Introduction to PLC: Definition, Features, and Industrial Applications.

Architecture of PLC: CPU, Input/Output modules, Power supply, Programming device.

Ladder Logic Programming: Logic gates (AND, OR, NOT, NAND, NOR), Latching circuits, Timers (TON, TOF, RTO), Counters (CTU, CTD).

PLC Control Applications: Hydraulic, Pneumatic, and Mechatronic systems with timing and counting sequences.

Introduction to SCADA system

Exemplars / Practical Applications and usage:

PLC are used in Conveyor belt control (automotive plants), Hydraulic press (metal stamping), pneumatic pick-and-place (PCB assembly), mechatronic washing machine (full timing sequence), and a traffic light controller with exact timer presets. Application of SCADA: water treatment, power grid, oil pipeline, manufacturing OEE

Comprehensive Continuous Evaluation (CCE) components for the course:

[Signature]



CCE 1 – Written Test (Total: 08 Marks)

Activity:

Students shall appear for a closed-book written test covering Unit 1 (Modern Sensors and Actuators) and

Unit 2 (Data Acquisition and Signal Communication Systems), assessing their foundational understanding of sensor characteristics, actuator types, DAQ architecture, signal conditioning, and communication protocols.

Expected Work:

- Short answer and descriptive questions
- Identification and classification of sensors and actuators
- Explanation of DAQ chain components and signal conditioning circuits
- Application of Nyquist criterion and sampling theorem

Submission:

- Written answer sheet during class
- Test conducted under closed-book conditions

CCE 2 - Individual Typed Assignment (08Marks)

Activity

Students individually investigate and respond to different technical tasks spanning Unit 1 (Modern Sensors & Actuators) and Unit 2 (DAQ & Signal Communication).

Expected Work:

- Each student must independently prepare and submit a typed assignment on A4-size paper
- Identification and classification of sensors and actuators for any application
- Explanation of DAQ chain components and signal conditioning circuits

Submission:

A4-size, typed responses with hand-drawn diagrams where required

CCE 3 - Field Activity / Industry Case Study (12 Marks)

Activity:

Groups of 3–4 students undertake a real-world or simulation-based investigation of a control system, covering Unit 3 (Mathematical Modelling & Control) and Unit 4 (Controllers) and Unit V (PLC). Each group selects ONE of the following two parts

1. Part 1 — Industry / Lab Visit
2. Part 2 — Product Case Study

Expected Work:

- Each group must produce a written report of 4–6 A4 pages and participate in a 5-minute viva. The expected content varies by option:
- Option A: Site visit report including photographs or sketches, block diagram with labelled signals, controller identification table, and a transfer function estimate with assumptions stated.
- Option B: System description, closed/open-loop identification with justification, block diagram, derivation or estimation of $G(s)$, steady-state error analysis, and a proposed PI/PID improvement with expected benefit.
- Option C: PLC Simulation Study — Develop a PLC ladder logic program for a given industrial sequence (e.g., conveyor, hydraulic press, or traffic light control) using simulation software (e.g., STEP 7, RSLogix, or open-source alternatives). The report must include: problem statement, I/O assignment table, annotated ladder logic rungs, timer and counter



configuration, and a simulated run trace or screenshot. A one-paragraph introductory note on how SCADA would monitor this process may be appended.

Submission:

- Written report, 4–6 pages A4; typed and bound/stapled

CCE 4 – Online Quiz (12 Marks)

Activity:

An individual quiz covering three units (3, 4, 5) of Mechatronics is conducted by the faculty. The quiz tests recall, understanding, and application. The quiz is divided unit-wise: 8 questions each from all five units (24 questions total, 0.5 M per question = 12 M),

Expected Work:

- Each student must individually attempt all 24 questions within the allotted 20–25 minutes.
- There is no negative marking.

Submission:

- Online (Kahoot / Google Forms) or offline (OMR / answer sheet) as decided by the faculty
- Duration: 20–25 minutes

Textbooks:

1. D. A. Bradley, D. Dawson, N. C. Burd & A. J. Loader, *Mechatronics: Electronics in Products and Processes*, Chapman & Hall, 2nd Edition, 2018.
2. D. G. Alciatore & M. B. Hstand, *Introduction to Mechatronics and Measurement Systems*, McGraw-Hill, 4th Edition, 2012.
3. W. Bolton, *Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering*, Pearson Education, 6th Edition, 2015.
4. Kevin Craig & Kevin Passino, *Mechatronics: An Introduction*, CRC Press, 2006.
5. Clarence W. de Silva, *Mechatronics: An Integrated Approach*, CRC Press / Taylor & Francis, 2005.

Reference Books:

1. N. S. Nise, *Control Systems Engineering*, John Wiley & Sons, 7th Edition, 2015.
2. R. Pallas-Areny & J. G. Webster, *Sensors and Signal Conditioning*, John Wiley & Sons, 2nd Edition, 2001.
3. Frank D. Petruzella, *Programmable Logic Controllers*, McGraw-Hill Education, 5th Edition, 2016.
4. David G. Alciatore, *Introduction to Mechatronics and Measurement Systems (Lab Manual)*, McGraw-Hill, 4th Edition, 2012.
5. Sabrie Soloman, *Sensors and Control Systems in Manufacturing*, McGraw-Hill, 2nd Edition, 2010.

MOOCs Links and additional reading material:

1. Mechatronics, IIT Roorkee: nptel.ac.in/courses/112107298
2. Mechatronics and Manufacturing Automation, IIT Guwahati: nptel.ac.in/courses/112103174
3. MATLAB Tutorials: <https://www.mathworks.com/learn/tutorials/matlab-onramp.html>
4. Control System: https://www.youtube.com/watch?v=oBc_BHxw78s&list=PLUMWjy5jgHK1NC52DXXrriwihVrYZKqjk&index=1&pp=iAQB
5. Programmable logic controller: <https://youtu.be/MS3qJq2jvu0>
6. PID Controller: <https://youtu.be/-To4nPh-N2A>
7. Frequency Domain Analysis: <https://youtu.be/tZISBqVQMic>

[Signature]

**CO-PO-PSO Mapping**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	3	1	2	2	2	–	3	3	1	2
CO2	3	3	2	3	3	1	2	2	2	–	3	2	2	2
CO3	3	3	2	2	3	1	2	2	2	–	3	3	2	1
CO4	3	3	2	2	3	1	2	2	3	–	3	3	2	3
CO5	3	2	2	1	3	1	2	2	3	–	3	3	2	3
Avg.	3	3	2	2	3	1	2	2	2	–	3	3	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Unit wise Weightage:

Exam	Unit1	Unit2	Unit3	Unit4	Unit V
CCE (40M)					
CCE 1(Written Test)	4	4			
CCE 2 (Assignment)	4	4			
CCE 3 (Field Activity / Industry Case Study)			4	4	4
CCE 4 (Quiz)			4	4	4
ESE (60M)	12	12	12	12	12
Total (100)	20	20	20	20	20

Assessment Pattern

BT Level	CCE										ESE				
	CCE1		CCE2		CCE3			CCE4							
CO	CO1	CO2	CO1	CO2	CO3	CO4	CO5	CO3	CO4	CO 5	CO1	CO2	CO3	CO4	CO5
L1															
L2	4	4			4	4		4	4	4	12	12	12	12	12
L3			4	4			4								
L4															
L5															
L6															

This course serves as a prerequisite for / maps with the following future courses: Advanced Robotics and Automation, Industrial Automation, Advanced Control Systems, Capstone Project in Mechatronics.

Job Mapping:

Job opportunities that one can get after learning this course: Automation Engineer, Robotics Engineer, Control Systems Engineer, Embedded Systems Developer, R&D Engineer in Smart Manufacturing.



Program:	S. Y. B. Tech	Semester:	IV
Course:	Workshop Practice	Course Code:	R25-ME-VSEC-216
Teaching Scheme			
Lecture	Practical	Tutorial	Credit
-	2	-	1

Examination Scheme			
CCE	ESE	TW	PR
-	-	25	25

Course Description and Relevance:

This course is providing a fundamental knowledge and hands-on skills related to basic manufacturing and fabrication processes used in engineering workshops and industries. The course introduces students to the safe operation of common workshop tools, machines, measuring instruments, and equipment used in various sections of workshop.

This subject helps to students in the development of technical competency, problem-solving ability, and practical engineering skills essential for manufacturing, maintenance, production, and industrial applications. It also creates awareness about modern workshop technologies, sustainable practices, and industrial safety standards required in today's engineering environment

Prerequisite:

- Manufacturing Processes
- Engineering Workshop Skills Lab
- Engineering Physics, Chemistry
- Engineering Graphics
- Engineering Materials and Metallurgy

Bridge Content:

Understanding the transformation of raw materials into finished products using conventional manufacturing processes.

Course Objectives:

1. To DEVELOP an understanding of safety standards and precautions applicable in mechanical workshops, industries, and service centers ensuring a safe working environment.
2. To ENHANCE practical skills in machining and production processes by performing multi-operation jobs involving various manufacturing techniques such as turning, milling, drilling, and surface finishing.
3. To PROVIDE hands-on experience in metal joining and fabrication processes, including welding (TIG, MIG, and GAS welding), soldering, and brazing, along with the study of related defects.
4. To FAMILIARIZE students with casting and forging processes, including defect analysis, process simulation, and real-world applications through industrial visits.
5. To ENABLE students to perform material selection, process planning, and cost estimation for engineering components and assemblies, incorporating green manufacturing principles and a variety of materials.

Course Outcomes: After learning the course, students will be able to

CO	Course Outcome	Bloom's Level
CO1	APPLY safety protocols effectively in mechanical workshop and related industrial environment to minimize risks and hazards.	3
CO2	DEMONSTRATE proficiency in machining operations and manufacturing processes through hands on production of assembly jobs using appropriate machining parameters.	2
CO3	PERFORM welding and fabrication techniques to join similar or dissimilar metals, analyze defects, and understand the applications of different joining methods.	3
CO4	UNDERSTAND moulding, casting and forging processes, identify casting defects,	2



CO5	PREPARE comprehensive material selection and manufacturing plans for multi-component engineering products, including process sheets, machining calculations, and cost analysis aligned with sustainable manufacturing practices.	3
Course Content		
List of Practical:		
Experiment No.1	Safety standards and safety measures	COs Mapped 1
		2 Hrs.
Objective: Study and analyze the safety standards and safety measures implemented in various sections of a mechanical workshop, Understanding of BS ISO 45001:2018 (Occupational health and safety management systems). Associated Tasks: 1. Prepare a report on safety precautions in workshop/industry centers etc. 2. Learn 4W1H formats and make the 5 observations of Safety and Cleanliness in workshop. Exemplars and Utility: Mechanical workshop layout planning, Machine tool safety implementation, Welding and fabrication safety management, Material handling and storage safety, Personal protective equipment (PPE) compliance and training.		
Experiment No.2	Composite Job	COs Mapped 2
		10 Hrs.
Objective: Manufacturing of simple composite job using any 3-4 of following machine tools like Lathe, Drilling, Milling, Grinding etc. Associated Tasks: (3-4 operations from the following list) 1. Raw material selection (Suitable for job in assignment) 2. Raw material preparation like hacksaw cutting, etc. 3. Rough and Finish turning on lathe machine. 4. Rough milling on Milling machine machining flats, gear cutting, keyways, etc. 5. Drilling/tapping/threading etc. 6. Surface finishing using Grinding/Polishing/Buffing, etc. 7. Surface treatment for corrosion/wear resistance, aesthetics, etc. Exemplars and Utility: 1. Selection of suitable Engineering material viz. ferrous/non-ferrous/non-metallic material available easily in market. 2. Select appropriate machines, cutting tools & machining parameters viz. Cutting Speed (V_c m/min), feed (mm/rev or mm/minute) & Depth of Cut (DoC)		
Experiment No.3	Welding Process	COs Mapped 3
		6 Hrs.
Objective: Fabrication of a component by joining two similar or dissimilar metals using TIG, MIG, or Arc welding techniques. Associated Tasks: 1. Identify suitable base metals (similar or dissimilar metals). 2. Select appropriate filler material and shielding gas. 3. Measure and mark the workpieces according to dimensions. 4. Prepare edge geometry (square butt, V-groove, bevel, etc.). 5. Set welding current, voltage, and gas flow rate. 6. Remove slag and spatters from the weld surface and Inspect. 7. Check for welding defects such as porosity, cracks, undercut, and lack of fusion. Exemplars and Utility:		



Automotive exhaust system fabrication, Aerospace frame assembly, Bicycle frame welding, Industrial piping and tubing fabrication, Custom metal furniture manufacturing

Experiment No.4	Mould Making	COs Mapped 4	2 Hrs.
Objective: Making a mould for given component in workshop using moulding sand.			
Associated Tasks: 1. Study the fundamentals of mould making and casting process. 2. Prepare moulding sand with proper moisture and binding materials. 3. Arrange cope, drag, flask, sprue pins, riser pins, and hand tools. 4. Place the pattern properly in the drag box, fill moulding sand around the pattern uniformly. 5. Ram the sand properly using hand rammer. Remove excess sand and level the surface. 6. Withdraw the pattern without damaging the mould cavity. 7. Check mould cavity dimensions and surface finish. Inspect gating and venting arrangements. 8. Understand the Metal Casting Process through the NPTEL/YouTube videos.			
Exemplars and Utility: Sand Casting Molds: A traditional, cost-effective method for creating metal parts, such as engine blocks, Educational model making, Small gear or pulley by sand-based mold.			
Experiment No.5	Sheet metal processing	COs Mapped 5	4 Hrs.
Objective: Manufacture a simple component using a press machine involving operations such as punching, blanking, bending, and shearing on sheet metal.			
Associated Tasks: 1. Study the fundamentals of sheet metal operations, Select suitable sheet material. 2. Measure dimensions according to drawing, cut sheet metal using cutting machines, minimize material wastage during cutting process. 3. Remove burrs and sharp edges, Check surface finish and dimensional accuracy. 4. Calculate strip width, pitch, and material utilization, prepare strip layout sketch for minimum material wastage.			
Exemplars and Utility: Car body panels, Sheet metal work in furniture etc.			
Textbooks: 1. Hajra Choudhary -Elements of Workshop Technology (Vol. I & II) 2. K.C. John - Mechanical Workshop Practice (2nd Ed.) 3. S.K. Yadav -Workshop Practice			
Virtual Lab, related open source/ subscription based software, Links or websites for lab conduction, animation, simulation etc., e-learning. 1. NPTEL - Industrial Safety Engineering http://www.digimat.in/npTEL/courses/video/110105094/L01.html 2. NPTEL – Metal Cutting and Machine Tools https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_me04 3. NPTEL – Casting Technology nptel.ac.in/courses/112107215 4. NPTEL – Mould Making https://www.youtube.com/watch?v=hf7VsCLr4Yw 5. NPTEL – Sheet metal Layout http://www.digimat.in/npTEL/courses/video/112103420/L01.html			

*Add additional rows as per requirement



CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	-	-	-	-	-	-	-	2
CO2	3	3	3	2	2	-	-	-	-	-	-	-	-	3
CO3	3	2	2	2	2	-	-	-	-	-	-	-	-	3
CO4	3	3	2	2	2	1	-	-	-	-	-	-	-	2
CO5	3	3	2	2	3	-	1	1	-	-	-	-	-	3
Avg.	3	2.8	2.2	2.0	2.2	0.2	0.2	0.2	0	0	0			2.6

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern

BT Level	CCE based on ARCV				
	Exp. 1	Exp. 2	Exp. 3	Exp. 4	Exp. 5
CO	CO1	CO2	CO3	CO4	CO5
L1					
L2		5		5	
L3	5		5		5
TOTAL	5	5	5	5	5

This course serves as a prerequisite for / maps with the following future courses:

1. Manufacturing Processes– I and II
2. Advanced Manufacturing Processes
3. Industrial Engineering

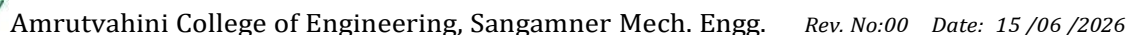
Job Mapping:

Job opportunities that one can get after learning this course:

1. Production Engineer
2. Manufacturing Engineer
3. Welding Engineer / Welding Inspector
4. Shop Floor Supervisor

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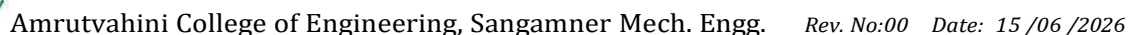
[Signature]



Tenny



4	5 T, T ि ि ि 7 TT ँ ि न U TT ग Apply technical writing principles in reports, presentations, and digital communication.	3
5	U ि 4 T, T ि T T न Demonstrate interpersonal communication, presentation, and teamwork skills.	3
Course Content		
Unit	Content	Hrs.
1	T, ि िरु िरु ि िरु िरु , िरु िरु िरु , DT िरु नरु 5 , r UDT िरु 5 िरु T, U िरु ; T ि न T िरु 3 U िरु िरु T, T न िरु ि न , TTU िरु िरु T T 5U Modern Indian Language and Communication Fundamentals Introduction to Modern Indian Languages, Importance of language in professional life, Basic grammar and vocabulary development, Listening and speaking skills, Conversational communication in formal and informal situations, Reading comprehension and interpretation, Communication barriers and effective communication practices	3
2	DT िरु िरु िरु T िरु 4 ि िरु िरु T, DT िरु िरु TT िरु U िरु 4 ; T िरु िरु िरु T िरु T, ग T िरु TU T, , TU िरु 4- , T 3 T 5U. Professional Communication and Workplace Interaction Verbal and non-verbal communication, Professional etiquette and interpersonal skills, Public speaking and confidence building, Group discussion and team communication, Interview skills and self-introduction, Workplace communication practices	3
3	UT िरु U TK िरु UT िरु नरु U ; UT िरु TM U T 4 UT, UT िरु , ग, UT िरु 5 िरु न , UT 5 T न, ग TT 5 T UT ; नरु िरु T 5U न, िरु 7 UT िरु TT न, UT िरु िरु (Abstract) न. Technical Writing Fundamentals Principles of technical writing, Clarity, precision, and coherence in technical documents, Technical vocabulary and style, Technical report writing, Laboratory report preparation, Writing instructions and procedures, Note making and summarization, Technical article and abstract writing	3



4	डिजिटल और पेशेवर दस्तावेज़ ईमेल लेखन और डिजिटल संचार नैतिकता, रीज्यूमे और कवर लेटर तैयारी, प्रोजेक्ट प्रस्ताव और प्रोजेक्ट सारांश लेखन, प्रस्तुति तकनीकें और दस्तावेज़ीकरण उपकरण, दस्तावेज़ीकरण सॉफ्टवेयर और प्रारूपण, प्रस्तावना अनुवाद और द्विभाषी तकनीकी संचार, तकनीकी संचार में नैतिक मुद्दे	3
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List of Practical:

Experiment No.1	4- रक तदर र (Self Introduction)	COs Mapped CO1	Hrs.
ि BT न िन rTU rT`U 3-3 िनि7T` 4- ि ि ओ/ ि T UT T, T `4 UT, ि T ि T rTTTT . Students should prepare a 2-3 minute self-introduction video or oral presentation in a Modern Indian Language, demonstrating clarity, confidence, and the use of formal language.			
Experiment No.2	तद तदर र (Dialogue Presentation)	COs Mapped CO5	Hrs.
ि BT न T ि T 5नग T Vन ि T न ि ि3U TU , T UT TT ि T TT.5T T T™ नTU ि3U - ि TT, ` TTTU ` , ` 3नT , गTU T, T r7, D3 T - T T, TT-ि T ि T ि--ि BT T T हWT . Students should work in pairs or small groups to create and perform a short role-play based on a given everyday scenario. This dialogue must relate to real-life situations, such as shopping in a market, making inquiries at a railway station, engaging in a classroom discussion, visiting a hospital, Manager – Employee Dialogue, Principal – Teacher Dialogue or participating in a teacher-student interaction.			
Experiment No.3	TU U T rTU तदर र (News Comprehension & Summary Presentation)	COs Mapped CO5	Hrs.
िनि T K TU (` , T T , , T , ि , U T TUT ह.) UT5 U ™r</p> <p>TTTT. wTU ि5U ` न Vन wTT ि™ TT` UT TT ि U Twि T ` T TT. UT ` ` T5T TT` ि BT T T न Trग न ि ` 4 5`. Students should read any one column from a daily Marathi newspaper covering sectors like sports, politics, finance, editorials, education, or international news. They must comprehend the information, prepare a concise summary, and present it during the practical session. This prepared summary must be included as part of the student's laboratory journal.			
Experiment No. 4	T (Book Review)	COs Mapped CO2	Hrs.



विद्यार्थ्यांनी कोणत्याही उपलब्ध पुस्तकाचा, कथा, किंवा काल्पनिक किंवा सामाजिक माध्यमावरील (Social Media Platform) लेख घ्यावा. Students should read any novel, fiction, or literary book of their choice. Subsequently, they must prepare an in-depth book review and publish it on a social media platform of their selection.			
Experiment No. 5	मराठी चित्रपटाचा (Marathi Movie Review)	COs Mapped CO2	Hrs.
Experiment No. 6	रिझ्युम आणि कवरेटर (Preparation of Resume & Cover Letter)	COs Mapped CO3	Hrs.
हार्नरिंग (Peer Review) करून घ्यावा. Students should prepare a resume and a cover letter suitable for an internship or job application, and then undergo a peer review process with their fellow classmates.			
Experiment No. 7	तंत्रिक दस्तऐवज (Technical Document Writing)	COs Mapped CO3	Hrs.
विद्यार्थ्यांनी (User Manual) किंवा (Process Description) तयार करावे, ते स्पष्ट आणि अचूक असावे. Students should prepare a user manual or process description document, ensuring high clarity and precision.			
Experiment No. 8	ईमेल (Email Writing)	COs Mapped CO4	Hrs.
व्यवसायिक ईमेल: प्रार्थना ईमेल, तक्रार ईमेल, आणि प्रश्न ईमेल, यात योग्य विषय, औपचारिक भाषा, आणि व्यवसायिक आचरण. Writing Professional Emails: Request emails, complaint emails, and inquiry emails, incorporating appropriate subject lines, formal language, and professional etiquette.			
Experiment No. 9	उत्सर्ग (Research Paper Review)	COs Mapped CO4	Hrs.
विद्यार्थ्यांनी (research paper) वाचून घ्यावे. Instruct students to read a selected research paper from a technical or engineering field and prepare a structured review of it.			
Textbooks:			
- उत्सर्ग, टी.टी. डॉ. केतकी मोडक, संतोष शेणई, सुजाता शेणई - आधुनिक मानव तंत्रज्ञानाच्या निष्ठा, नशक्रापरकर दीपक, मराठे उज्ज्वल, उत्कृष्ट प्रकाशन - व्यवसायिक मराठी, डॉ. नसीराबादकर, फडके प्रकाशन			
Reference Books:			
1. Professional Communication, ना. न. गुट्ट			
Virtual Lab, related open source/ subscription based software, Links or websites for lab conduction, animation, simulation etc., e-learning.			

(Signature)

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1. Resume writing
https://www.mycvcreator.com/?gad_source=1&gad_campaignid=23192379510&gbraid=0AAAAAoz1mGn7s_uIvUZeW3jYIDOEWDLSy&gclid=EAIaIQobChMIwHTt923lAMVFso8Ah3eBwG0EAAAYASAAEgKPxD_BwE
2. Literature Review: <https://www.paperdigest.org/review/>
3. Review writing: <https://lekhakmitra.com/how-to-write-a-movie-review-in-marathi/>

*Add additional rows as per requirement

CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-		2	3	-	2	-	-	-
CO2	-	-	-	-	-	-	3	2	2	-	-	-	-	-
CO3	-	-	-	-	2	-	-	-	2	-	-	-	-	-
CO4	-	-	-	-	2	-	-	2	3	-	-	-	-	-
CO5	-	-	-	-	-	-	2	3	3	-	-	-	-	-
Avg.	-	-	-	-	2	-	2.5	2.25	2.6	-	2	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern

BT	CCE based on ARCV								
Level	Exp. 1	Exp. 2	Exp. 3	Exp. 4	Exp. 5	Exp. 6	Exp. 7	Exp. 8	Exp. 9
CO	CO1	CO5	CO5	CO2	CO2	CO3	CO3	CO4	CO4
L1									
L2	5			5	6	6	6		
L3		5	5					6	6
L4									
L5									
L6									

This course serves as a prerequisite for / maps with the following future courses:

Job Mapping:

Job opportunities that one can get after learning this course:

Amrutvahini

R. Ganesh



Program:		S. Y. B. Tech (Mechanical Engineering)		Semester:		IV	
Course:		Entrepreneurship and Financial Management		Course Code:		R25-ME-HSSM-218	
Teaching Scheme				Examination Scheme			
Lecture	Practical	Tutorial	Credit	CCE	ESE	TW	PR
02	--	--	--	50	--	--	--
Course Description and Relevance: This course introduces the fundamental concepts of entrepreneurship, business formation, financial management, accounting, budgeting, and enterprise growth with emphasis on engineering and industrial applications. The course covers entrepreneurial opportunities, startup financing, accounting principles, financial analysis, marketing, business planning, and national and international business systems required for effective managerial and financial decision-making. The course is highly relevant for engineering students as it develops understanding of entrepreneurial and financial aspects involved in industrial operations, startups, and business organizations. It helps students acquire skills related to financial planning, budgeting, cost analysis, business management, and strategic decision-making essential for engineering enterprises. The course also creates awareness about globalization, trade practices, sustainability, and emerging business opportunities, thereby preparing students for entrepreneurship, management roles, and innovation-driven industrial careers.							
Prerequisite: Basic knowledge of mathematics, communication skills, analytical and logical thinking, and awareness of engineering, industrial, and business operations.							
Bridge Content: Introduction to basic business and management terminology, fundamentals of economics and accounting, overview of entrepreneurship and financial concepts, basics of budgeting and cost analysis, and awareness of industrial operations, communication, and decision-making processes relevant to engineering applications.							
Course Objectives: 							

**Exemplars / Practical Applications and usage:**

Identification of entrepreneurial opportunities in manufacturing and mechanical industries; preparation of simple business registration procedures for startups; case studies of successful entrepreneurs and startups; analysis of business ethics and professional responsibility in engineering enterprises.

Unit 2	Fundamentals of Financial Management	8 Hrs.	COs Mapped CO2
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Meaning and objectives of financial management, Financial planning for startups, Sources of finance: Equity, Debt, Venture capital, Angel investment, Crowd funding, Government funding schemes, Time value of money, Cost concepts: Fixed cost, Variable cost, Break even analysis, Working capital management basics.

Exemplars / Practical Applications and usage:

Preparation of financial plans for startup ideas, calculation of break-even point and working capital requirements; analysis of funding sources such as venture capital, angel investment, and government schemes, applications of time value of money in engineering and business decisions.

Unit 3	Accounting and Financial Analysis for Entrepreneurs	8 Hrs.	COs Mapped CO3
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Basics of accounting, Financial statements: Balance Sheet, Profit & Loss Account, Cash Flow Statement. Depreciation concepts, Budgeting and forecasting, Ratio analysis: Liquidity ratios, Profitability ratios, Efficiency ratios, Pricing strategies for engineering products, Financial decision making basics

Exemplars / Practical Applications and usage:

Preparation and analysis of Balance Sheet, Profit & Loss Account, Cash Flow Statement; budgeting and forecasting for small business operations; calculation of liquidity and profitability ratios; pricing analysis for engineering and manufacturing products.

Unit 4	Managing and Growing an Enterprise	8 Hrs.	COs Mapped CO4
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Marketing fundamentals for startups, Digital marketing basics, Operations and supply chain basics, Risk management in business, Project feasibility analysis, Business planning and report preparation, Funding pitch preparation, Scaling and sustainability of enterprises, Case studies of successful engineering enterprises.

Exemplars / Practical Applications and usage:

Preparation of business plans and funding pitch presentations for startups; application of digital marketing strategies for engineering products; feasibility analysis of small business projects; case studies of successful engineering enterprises and sustainable business growth practices.

Comprehensive Continuous Evaluation (CCE) components for the course:

- 1. Assignments:** Open-ended assignments on entrepreneurship concepts, financial planning, accounting, budgeting, and business analysis.
- 2. Case Study Analysis:** Analysis of startup ventures, business organizations, financial management practices, and entrepreneurial success stories.
- 3. Seminar / Presentation:** Individual or group presentations on topics such as startup funding, digital marketing, globalization, financial management, and business planning.
- 4. Group Discussion / Team Activity:** Discussion on entrepreneurship opportunities, business ethics, financial decision-making, and enterprise growth strategies.

Textbooks:

1. Donald A. Hay and Derek J. Morris, Industrial Economics and Organization: Theory and Evidence, Oxford University Press, 1991.
2. Sanjaya Lall, Competitiveness, Technology and Skills, Edward Elgar Publishing, 2001.
3. F. M. Scherer and D. Ross, Industrial Market Structure and Economic Performance, Houghton Mifflin, 1990.
4. Dr. Kaustubh Sontakke, Financial Accounting, Himalaya Publishing House, 2020.
5. Prasanna Chandra, Financial Management: Theory and Practice, Tata McGraw Hill, 2004.

Reference Books:



1. Jawahar Lal, Accounting Theory and Practice, Himalaya Publishing House, 2021.
2. Richard A. Brealey and Stewart C. Myers, Principles of Corporate Finance, McGraw Hill Education, 1988.
3. Tara Chand, Engineering Economics, Nem Chand and Brothers, 2010.
4. G. J. Thuesen and W. J. Fabrycky, Engineering Economy, Prentice Hall of India, 2001.
5. T. R. Banga and S. C. Sharma, Mechanical Estimating and Costing, Khanna Publishers, 2014.
6. T. R. Banga and S. C. Sharma, Industrial Organization and Engineering Economics, Khanna Publishers, 2012.
7. D. Kannappan et al., Mechanical Estimating and Costing, Tata McGraw Hill Publishing Company, 2006.
8. O. P. Khanna, A Text Book of Mechanical Estimating and Costing, Dhanpat Rai Publications, 2013.
9. O. P. Khanna, Industrial Engineering and Management, Dhanpat Rai and Sons, 2015.
10. I. M. Pandey, Financial Management, Vikas Publishing House, 2021.
11. James L. Riggs, David D. Bedworth, and Sabah U. Randhawa, Engineering Economics, Tata McGraw Hill Publishing Co. Ltd., 2005.
12. Paul DeGarmo, Engineering Economy, Macmillan International Inc., 1997.

MOOCs Links and additional reading material:

1. Introduction to fintech, <https://www.my-mooc.com/en/mooc/introduction-to-fintech/>
2. New age business model, https://onlinecourses.swayam2.ac.in/e-learning/preview/imb25_mg44
3. Basics of Financial Management – NPTEL <https://nptel.ac.in/courses/110107144>

CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	–	–	–	2	–	3	1	2	2	1	–	2
CO2	2	3	1	–	1	2	–	2	1	1	3	2	1	2
CO3	2	3	2	1	1	–	–	1	–	1	3	2	2	1
CO4	1	2	2	1	1	2	2	2	2	3	2	1	2	2
CO5	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Avg.	1.75	2.50	1.25	0.50	0.75	1.50	0.50	2.00	1.00	1.75	2.50	1.50	1.25	1.75

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Unit wise Weightage:

Exam	Unit 1	Unit 2	Unit 3	Unit 4	-
CCE	12	13	13	12	-
ESE	-	-	-	-	-
Total	12	13	13	12	-

Amrutvahini

R. Gaurav

**Assessment Pattern**

BT Level	CCE						ESE				
	CCE1	CCE2	CCE3	CCE4			CO1	CO2	CO3	CO4	CO5
CO	CO1	CO2	CO3	CO4	-	-	CO1	CO2	CO3	CO4	CO5
L1	-	-	-	-	-	-	-	-	-	-	-
L2	12	-	-	12	-	-	-	-	-	-	-
L3		13	13	-	-	-	-	-	-	-	-
L4	-	-	-	-	-	-	-	-	-	-	-
L5	-	-	-	-	-	-	-	-	-	-	-
L6	-	-	-	-	-	-	-	-	-	-	-
Total	12	13	13	12	-	-	-	-	-	-	-

This course serves as a prerequisite for / maps with the following future courses:-

Job Mapping:

Job opportunities that one can get after learning this course:

Entrepreneur / Startup Founder



Program:		S. Y. B. Tech			Semester:		IV	
Course:		Mechatronics and IOT			Course Code:		R25-ME-PCC-219	
Teaching Scheme				Examination Scheme				
Lecture	Practical	Tutorial	Credit	CCE	ESE	TW	PR	
--	02	--	01	--	--	--	25	
Course Description and Relevance: This practical course provides second-year Mechanical Engineering students with hands-on experience in building, programming, and deploying intelligent mechatronic and IoT systems. Through ten structured experiments, students’ progress from sensor calibration and data acquisition to PID control implementation, PLC-based circuit operation, and cloud-connected IoT system deployment. Each experiment is rooted in real engineering practice and culminates in a mini-project that integrates all acquired skills into a working, end-to-end IoT-enabled mechatronic solution. The laboratory work is designed to complement theoretical understanding with direct implementation experience — students write embedded firmware for Arduino and ESP32 platforms, interface motor driver ICs, simulate dynamic systems in MATLAB/Simulink or Python, and establish wireless connectivity to remote dashboards. By the end of the course, students are able to select appropriate sensors and actuators, design signal acquisition pipelines, apply classical control strategies in hardware, and integrate subsystems into connected, intelligent devices.								
Prerequisite: 1. Basic Physics (mechanics, electrical circuits, energy systems) 2. Engineering Mathematics (differential equations, Laplace transforms) 3. Basic knowledge of electronic components. 4. Programming fundamentals (C/C++ or Python).								
Bridge Content: Students should review Ohm's Law, basic circuit analysis, Newton's Laws, and introductory programming constructs before starting this course.								
Course Objectives: 1. To IDENTIFY the types, key characteristics, and working principles of modern sensors and actuators commonly used in mechatronic systems. 2. To EXPLAIN signal conditioning and data acquisition architectures, and the operation of industrial serial communication protocols used in embedded mechatronic systems. 3. To APPLY mathematical modelling and simulation techniques to determine the dynamic response and stability of mechatronic systems. 4. To IMPLEMENT continuous-domain PID and discrete-time digital controller design methods on microcontroller and PLC platforms. 5. To DEPLOY IoT platforms and wireless communication protocols to design and implement remote monitoring and control systems for mechatronic applications.								
Course Outcomes: After learning the course, students will be able to								
CO	Course Outcome						Bloom’s Level	
CO1	CLASSIFY modern sensors and actuators based on their characteristics and suitability for mechatronic applications.						2	
CO2	CONSTRUCT a data acquisition system by applying signal conditioning and appropriate serial communication protocols for embedded system interfacing.						3	
CO3	SOLVE dynamic response and stability problems of mechatronic systems using mathematical modelling and simulation techniques.						3	
CO4	APPLY PID and classical controller design methods on microcontroller and PLC platforms for practical control tasks.						3	
CO5	INTEGRATE IoT platforms and wireless protocols to build and monitor basic mechatronic control systems.						3	
Course Content								



List of Practical:			
Experiment No.1	Calibration and Characterization of Sensors	COs Mapped CO1	02 Hrs
Objective: To calibrate and characterize temperature, pressure, and proximity sensors for accurate measurement in embedded systems. Associated Tasks: 1. Connect temperature, pressure, and proximity sensors to the microcontroller. 2. Record raw sensor output values at known reference points. 3. Plot the sensor response curve and derive calibration constants. 4. Apply correction formulas in firmware to obtain accurate readings. 5. Verify calibrated output against reference instrument values. Exemplars and Utility: Industrial Process Control – Calibrated sensors ensure accurate measurement of temperature and pressure in manufacturing plants, preventing product defects. HVAC Systems – Proximity and temperature sensors are calibrated to maintain optimal environmental conditions in smart buildings.			
Experiment No.2	Data Acquisition System Using Arduino	COs Mapped: CO2	02 Hrs
Objective: To design and implement a data acquisition system using Arduino and suitable software to collect and display real-time sensor data Associated Tasks: 1. Interface analog/digital sensors with Arduino. 2. Write a program to read and process sensor data at regular intervals. 3. Transmit acquired data to a PC using serial communication. 4. Visualize the data using suitable software (e.g., Serial Plotter, MATLAB, or Python). 5. Log the data to a file for further analysis. Exemplars and Utility: Environmental Monitoring – Real-time data acquisition systems track temperature, humidity, and air quality in smart weather stations. Structural Health Monitoring – DAQ systems record vibration and strain data from bridges and buildings to detect structural anomalies.			
Experiment No.3	Interfacing IR or Ultrasonic Sensor for Distance Measurement	COs Mapped: CO3	02 Hrs
Objective: To measure distance using an ultrasonic sensor and display results on LCD or Serial Monitor. Associated Tasks: 1. Connect HC-SR04 sensor to Arduino. 2. Write code to calculate distance using time of flight. 3. Display output in cm on LCD or Serial Monitor. Exemplars and Utility: Robotics & Autonomous Navigation – Mobile robots (e.g., Arduino-based obstacle-avoiding robots) use HC-SR04 to detect walls, furniture, or humans in their path. Automotive Parking Assist Systems – Modern vehicles use ultrasonic sensors (similar in principle to HC-SR04) in bumpers to measure the distance between the car and obstacles during parking			
Experiment No.4	Modelling and Simulation of a Spring-Mass-Damper System	COs Mapped: CO3	02 Hrs
Objective: To model and simulate the dynamic behavior of a Spring-Mass-Damper system using suitable software (MATLAB/Simulink or Python). Associated Tasks:			



1. Derive the mathematical equation of motion for the Spring-Mass-Damper system.
2. Define system parameters: mass (m), spring constant (k), and damping coefficient (c).
3. Implement the model in MATLAB/Simulink or Python.
4. Simulate system response for step, impulse, and sinusoidal inputs.
5. Analyze underdamped, critically damped, and overdamped conditions from the output plots.

Exemplars and Utility:

Vehicle Suspension Design – Spring-mass-damper models are used to simulate and optimize automobile suspension systems for ride comfort.

Vibration Isolation Systems – Industrial machinery mounts are designed using damper models to minimize vibration transmission to structures.

Experiment No.5	Digital PID Implementation on Arduino for DC Servo Position Control	COs Mapped: CO4	02 Hrs
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Objective: To implement a Digital PID controller on Arduino for accurate position control of a DC servo motor.

Associated Tasks:

1. Interface a DC servo motor with Arduino using a PWM signal.
2. Read the current position using a feedback sensor (potentiometer or encoder).
3. Implement the PID algorithm (Proportional, Integral, Derivative) in the Arduino program.
4. Tune the PID gains (K_p , K_i , K_d) to achieve stable and accurate position control.
5. Observe the system response and minimize overshoot and steady-state error.

Exemplars and Utility:

Robotic Arm Control – PID controllers are used in robotic joints to achieve precise angular positioning and smooth movement.

CNC Machine Axes – Digital PID loops maintain accurate position control of cutting tool axes in CNC milling and turning machines.

Experiment No.6	PLC Controlled Electro-Hydraulic / Electro-Pneumatic Circuit	COs Mapped: CO4	02 Hrs
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Objective: To demonstrate the operation and control of an electro-hydraulic or electro-pneumatic circuit using a Programmable Logic Controller (PLC).

Associated Tasks:

1. Identify and connect hydraulic/pneumatic actuators, valves, and sensors to the PLC I/O.
2. Write a ladder logic program in the PLC software for sequential circuit operation.
3. Configure input sensors (limit switches, pressure sensors) and output actuators (solenoid valves, cylinders).
4. Simulate and test the program using PLC software before downloading to hardware.
5. Run the circuit and observe the actuator sequence controlled by the PLC.

Exemplars and Utility:

Automated Press Machines – PLC-controlled hydraulic circuits operate industrial presses with precise force and stroke control.

Pneumatic Pick-and-Place Systems – Electro-pneumatic circuits controlled by PLCs are used in assembly lines for material handling

Experiment No.7	Controlling DC Motor Using Transistor Driver Circuit with ESP32	COs Mapped: CO4	02 Hrs
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Objective: To control the speed and direction of a DC motor using a transistor driver circuit interfaced with an ESP32 microcontroller.

Associated Tasks:

1. Design and assemble a transistor-based H-bridge or driver circuit for the DC motor.
2. Connect the driver circuit to the ESP32 GPIO and PWM output pins.
3. Write an ESP32 program to control motor speed using PWM duty cycle variation.
4. Implement direction control (forward/reverse) through GPIO logic.
5. Observe motor speed changes on the Serial Monitor or using a tachometer.

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Exemplars and Utility:

Conveyor Belt Speed Control – DC motors driven by transistor circuits with PWM control are used in conveyor systems for variable speed operation.

Mobile Robotics – ESP32-based motor drivers control the drive wheels of autonomous robots for navigation and speed regulation.

Experiment No.8	Stepper Motor Control via Microcontroller Using L293D Driver	COs Mapped: CO4	02 Hrs
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Objective: To control a stepper motor using a microcontroller and the L293D motor driver IC for precise angular displacement

Associated Tasks:

1. Interface the stepper motor with the microcontroller through the L293D driver IC.
2. Write a program to implement full-step and half-step driving sequences.
3. Control the number of steps, direction, and speed of the stepper motor.
4. Verify angular position accuracy by counting steps and measuring rotation.
5. Implement a simple position control application (e.g., move to a specified angle).

Exemplars and Utility:

3D Printer Axis Control – Stepper motors with microcontroller-based drivers precisely position the print head and build platform in 3D printers.

Automated Valve Actuation – Stepper motors are used in fluid control systems to position valves at exact angles for flow regulation.

Experiment No.9	Mini-Project: End-to-End Design and Deployment of an IoT-Enabled Mechatronic System.	COs Mapped: CO5	02 Hrs
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Objective:

To design, build, and deploy a complete IoT-enabled mechatronic system integrating sensors, actuators, embedded control, and cloud/remote monitoring.

Associated Tasks:

1. Identify a real-world problem and define system requirements for an IoT mechatronic solution.
2. Select and interface appropriate sensors and actuators with a suitable microcontroller (e.g., ESP32).
3. Develop embedded firmware for data acquisition, processing, and actuation.
4. Establish wireless connectivity (Wi-Fi/MQTT/HTTP) and transmit data to a cloud platform or dashboard.
5. Test, debug, and demonstrate the fully functional IoT mechatronic system.

Exemplars and Utility:

Smart Irrigation System – An IoT-enabled system monitors soil moisture via sensors and automatically controls water pumps, with data logged to the cloud for remote monitoring.

Industrial Equipment Health Monitor – A mechatronic IoT device reads vibration and temperature from machines, triggers alerts, and sends real-time data to a web dashboard for predictive maintenance.

Experiment No.10	Field Visit / Industrial Visit	COs Mapped: CO1-CO5	02 Hrs
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Objective: To expose students to real-world industrial environments and observe the practical application of mechatronics, automation, and embedded systems in manufacturing or process industries.

Associated Tasks:

1. Visit a manufacturing plant, automation industry, or research facility.
2. Observe and document the use of sensors, actuators, PLCs, robots, and control systems.
3. Interact with engineers to understand system design and operational challenges.
4. Identify connections between classroom concepts and industrial applications observed.
5. Prepare a visit report summarizing observations, learnings, and industry insights.

Exemplars and Utility:

Automotive Manufacturing Plant – Observation of robotic welding, assembly lines, and PLC-controlled conveyor systems demonstrates large-scale mechatronics integration.

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Water Treatment Facility – SCADA systems, automated chemical dosing, and sensor-based monitoring illustrate real-world process control and IoT applications

Textbooks:

1. D. A. Bradley et al., Mechatronics, Chapman & Hall, Latest Edition.
2. D. G. Alciatore, Introduction to Mechatronics and Measurement Systems, McGraw-Hill, 4th Edition.
3. K. Ogata- Modern Control Engineering, Prentice Hall, 5th Edition

Reference Books:

1. N. S. Nise, Control Systems Engineering, Wiley, 7th Edition.
2. Arshdeep Bahga and Vijay Madisetti, Internet of Things, VPT, 2014
3. R. Pallas-Areny and J. G. Webster, Sensors and Signal Conditioning, Wiley, 2nd Edition
4. Frank D. Petruzella, Programmable Logic Controllers, McGraw-Hill

Virtual Lab, related open source/ subscription-based software, Links or websites for lab conduction, animation, simulation etc., e-learning.

1. How to control Stepper motor with Arduino: - <https://www.youtube.com/watch?v=8jkHvBSUKyU>
2. DC Motor Control using L298N Motor Driver & ESP32: - <https://www.youtube.com/watch?v=SEfYIT7NG7E>
3. Virtual Factory visit: - [Digital Enterprise | Siemens](https://www.digital-enterprise.com)
4. How to control Stepper motor with Arduino: - <https://youtu.be/8jkHvBSUKyU>.
5. Introduction to Embedded Systems: nptel.ac.in/courses/108102169
6. The Arduino Platform and C Programming | Coursera: <https://www.coursera.org/learn/arduino-platform>

*Add additional rows as per requirement

CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	3	1	2	2	2	-	3	3	1	2
CO2	3	3	2	3	3	1	2	2	2	-	3	2	2	2
CO3	3	3	2	2	3	1	2	2	2	-	3	3	2	1
CO4	3	3	2	2	3	1	2	2	3	-	3	3	2	3
CO5	3	3	2	1	3	2	2	2	3	-	3	2	2	3
Avg.	3.0	3.0	2.0	2.0	3.0	1.0	2.0	2.0	2.0	-	3.0	3.0	2.0	2.0

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern

BT Level	CCE based on ARCV(A5+R5+C5+V5)									
	Exp. 1	Exp. 2	Exp. 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp 10
CO	CO1	CO2		CO3	CO4				CO5	CO1-CO5
L1										
L2	20									
L3		20	20	20	20	20	20	20	20	20
L4										
L5										
L6										

This course serves as a prerequisite for / maps with the following future courses:

Advanced Robotics and Automation, Industrial Automation, Advanced Control Systems, Capstone Project in Mechatronics / IoT.

Job Mapping:

Job opportunities that one can get after learning this course: Automation Engineer, IoT Solutions Developer, Robotics Engineer, Control Systems Engineer, Embedded Systems Developer, Industry 4.0 Consultant, R&D Engineer in Smart Manufacturing.

Amrutvahini

R. Gaurav



Program:	S. Y. B. Tech	Semester:	IV
Course:	Thermo-Fluid Engineering Lab	Course Code:	R25-ME-PCC-220
Teaching Scheme			
Lecture	Practical	Tutorial	Credit
-	02	-	1

Examination Scheme			
CCE	ESE	TW	PR
-	-	25	-

Course Description and Relevance:

The Thermo-Fluid Engineering Lab is designed to provide practical exposure to the fundamental concepts of thermodynamics, fluid mechanics, heat transfer, and internal combustion engines through laboratory experimentation. The course enables students to understand the working principles and performance characteristics of thermo-fluid equipment such as boilers, calorimeters, engines, compressors, and flow measuring devices. Students develop the ability to conduct experiments, record observations, analyze data, and interpret engineering results using standard laboratory procedures. The laboratory also strengthens analytical thinking, teamwork, technical reporting, and problem-solving skills through hands-on experimentation and industrial exposure. The course bridges theoretical concepts with industrial applications and prepares students for advanced mechanical engineering subjects and professional practice.

The Thermo-Fluid Engineering Lab is highly relevant to mechanical engineering because thermo-fluid systems are widely used in industries such as power plants, automobile engineering, manufacturing, refrigeration, aerospace, and process industries. The experiments help students understand energy conversion, fluid flow behavior, heat transfer mechanisms, lubrication systems, and engine performance under real operating conditions. The course develops practical competency in operating engineering instruments, collecting experimental data, and evaluating system efficiency, which are essential skills for industrial and research applications. The industrial visit component further enhances students' understanding of maintenance practices, safety standards, and real-world engineering operations. Overall, the course supports the development of professional engineering skills required for design, operation, testing, maintenance, and optimization of thermo-fluid systems.

Prerequisite:

1. Basics of Engineering Thermodynamics
2. Applied Thermodynamics
3. Fluid Mechanics

Bridge Content: No Need**Course Objectives:**

1. To UNDERSTAND steam generation and thermodynamic properties through practical experiments using calorimetry and boilers.
2. To EVALUATE the performance and efficiency of internal combustion engines and air compressors through actual test methods.
3. To APPLY fluid mechanics principles such as Bernoulli's theorem, pressure loss, and flow measurement using lab equipment.
4. To INVESTIGATE fluid and lubricant properties including viscosity and discharge coefficients using standard instruments.
5. To DEVELOP practical insights into industrial applications of thermo-fluid systems through plant visits and technical documentation.

Course Outcomes: After learning the course, students will be able to

CO	Course Outcome	Bloom's Level
CO1	To UNDERSTAND steam generation and thermodynamic properties through practical experiments using calorimeters and boilers.	3
CO2	To EVALUATE the performance and efficiency of internal combustion engines and through actual test methods.	3
CO3	To APPLY fluid mechanics principles such as Bernoulli's theorem, pressure loss, and	3



	flow measurement using lab equipment.	
CO4	To INVESTIGATE fluid and lubricant properties including viscosity and discharge coefficients using standard instruments.	3
CO5	To DEVELOP practical insights into industrial applications of thermo-fluid systems through plant visits and technical documentation.	3
Course Content		
List of Practical:		
Experiment No.1	Trial on Boiler	COs Mapped CO1
Objective: To conduct a trial on a boiler to determine boiler efficiency, equivalent evaporation and Energy Balance. Associated Tasks: The boiler trial helps evaluate the performance of the boiler and identify possible inefficiencies due to losses through flue gases ➤ Measure engine speed at different load condition & brake load using dynamometer arrangement. ➤ Measure fuel consumption rate for each load condition, cooling water inlet and outlet temperatures, exhaust gas temperature ➤ Determine brake power, specific fuel consumption (SFC), Calculate brake thermal efficiency. ➤ Plot performance curves (BP vs SFC, BP vs efficiency, etc.). ➤ Prepare the heat balance sheet for the engine. ➤ Analyze experimental results and performance characteristics.		
Experiment No.2	Determination of dynamic and kinematic viscosity	COs Mapped CO4
Objective: Determination of dynamic and kinematic viscosity of any oil using Redwood Viscometer. Associated Tasks: Use the Redwood Viscometer to measure the time taken for a fixed quantity of oil to flow through the orifice to complete following tasks: ➤ Measure the flow time of oil & Determine Redwood seconds ➤ Calculate kinematic viscosity & dynamic viscosity ➤ Study the effect of temperature on viscosity & Plot graph of Viscosity vs Temperature ➤ Compare results with standard values Exemplars and Utility: It is used in selection of lubricants, hydraulic brake system, coating and spray painting. In manufacturing processes like ink production, adhesives and food processing.		
Experiment No.3	Bernoulli's Theorem experimental Demonstration and verification	COs Mapped CO3
Objective: To verify of Bernoulli's Theorem experimentally through Demonstration. Associated Tasks: Assemble and Inspect the Apparatus to Identify components like converging/diverging duct or venturi section, piezometer tubes/manometer, flow control valve, measuring tank, and ensure no air bubbles in pressure tubes, Check steady water flow to complete following tasks, ➤ Measure Flow Rate & Record Pressure Head at Different Sections ➤ Determine Velocity at Different Sections & Calculate Different Heads ➤ Verify Bernoulli's Theorem & Observe Energy Changes ➤ Plot Graphs like Pressure head vs pipe length, Total head line, Hydraulic grade line Exemplars and Utility: : The principle is used in atomizers like perfume bottles, in carburetors, in designing the wings of the airplanes		
Experiment No.4	Determination of Major and Minor Losses in Pipe Lines	COs Mapped CO3
Objective: To determine the friction factor for flow through circular pipes and to evaluate the head losses caused by sudden contraction and sudden expansion in pipe flow Associated Tasks: To determine the friction factor for flow through a circular pipe and study the major head losses occurring due to pipe friction, following tasks are to be considered		



- Measure the head loss due to sudden contraction in a pipe.
- Measure the head loss due to sudden expansion in a pipe.
- Compare the experimentally obtained friction factor with theoretical relations such as the Darcy–Weisbach equation.
- Study the variation of head loss with discharge/velocity and Reynolds number.

Exemplars and Utility: In food processing industries, chemical industries, piping industries and hydraulic power plants.

Experiment No.5	Determination of Coefficient of discharge of Venturimeter / orifice meter	COs Mapped CO4	02 Hrs.
Objective: To determine the coefficient of discharge of a Venturimeter and compare actual discharge with theoretical discharge / orifice meter Associated Tasks: To experimentally determine the coefficient of discharge of a Venturimeter by comparing: actual discharge (measured practically), and theoretical discharge ➤ Set up the Venturimeter apparatus ➤ Measure pressure difference & actual discharge ➤ Calculate theoretical discharge & Determine coefficient of discharge Exemplars and Utility: For accurate measurement of flow of fluids in pipelines in various industries like chemical processing, Oil and gas, food processing, automotive and aerospace etc.			
Experiment No.6	Performance test on a I.C. engine and to draw heat balance sheet	COs Mapped CO2	
Objective: To conduct a trial on a I.C. engine to determine brake power, fuel consumption, thermal efficiencies, and specific fuel consumption and to prepare a heat balance sheet for the engine. Associated Tasks: The Performance test on Diesel engine provides insight into engine efficiency and energy distribution. A good-performing diesel engine will have brake thermal efficiency around 30–40%, and remaining losses in cooling, exhaust, and radiation. Following are the tasks to be completed during experimentation, ➤ Preparation and Inspection of Engine Setup & Starting and Warm-Up of Engine ➤ Applying Load on the Engine & Measurement of Engine Speed, Fuel Consumption, Cooling Water Parameters, Exhaust Gas Temperature ➤ Calculation of Brake Power, Fuel Consumption Rate, Specific Fuel Consumption, Thermal Efficiencies, Preparation of Heat Balance Sheet ➤ Analysis of Performance Results Exemplars and Utility: In automobiles like heavy vehicles such as trucks and buses. In power plants for generation of power. Tractors and other farm machineries using diesel engines.			
Experiment No.7	Trial on a I.C. engine	COs Mapped CO2	02 Hrs.
Objective: To conduct a trial on a I.C. engine to determine brake power, fuel consumption, thermal efficiencies, and specific fuel consumption and to prepare a heat balance sheet for the engine. Associated Tasks: The Performance test on Diesel engine provides insight into engine efficiency and energy distribution. A good-performing diesel engine will have brake thermal efficiency around 30–40%, and remaining losses in cooling, exhaust, and radiation. Following are the tasks to be completed during experimentation, ➤ Preparation and Inspection of Engine Setup & Starting and Warm-Up of Engine ➤ Applying Load on the Engine & Measurement of Engine Speed, Fuel Consumption, Cooling Water Parameters, Exhaust Gas Temperature ➤ Calculation of Brake Power, Fuel Consumption Rate, Specific Fuel Consumption, Thermal Efficiencies, Preparation of Heat Balance Sheet ➤ Analysis of Performance Results Exemplars and Utility: In automobiles like heavy vehicles such as trucks and buses. In power plants for generation of power. Tractors and other farm machineries using diesel engines.			
Experiment No.8	Morse Test	COs Mapped	02 Hrs.

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		CO2	
Objective: To conduct the Morse test on multi cylinder Petrol engine. Associated Tasks: ➤ Measure the total brake power (BP) of the engine. ➤ Cut out one cylinder at a time and record the reduced brake power. ➤ Determine the indicated power (IP) of each cylinder. ➤ Calculate the total indicated power of the engine. ➤ Determine the friction power (FP) of the engine. ➤ Compare power contribution of individual cylinders Exemplars and Utility: In automobiles like cars and motorcycles, In smaller and portable machinery like lawn movers and generators.			
Experiment No.9	Industrial Visit	COs Mapped CO5	02 Hrs.
Objective: Visit to an Automobile Service station. Associated Tasks: The working of Internal Combustion engines, method of cooling system employed, lubrication and various parts of an engine and their working can be understood with the visit to any service station. ➤ Observe the overall layout of the automobile service station, Identify different service departments and their functions ➤ Study the tools and equipment used in servicing ,Observe vehicle lifting and handling methods ➤ Inspect wheel alignment and balancing procedures, Study engine diagnostic techniques ➤ Observe battery testing and charging process, Examine lubrication and oil changing procedure ➤ Study brake inspection and servicing methods, Observe cooling system maintenance practices ➤ Observe tyre inspection and replacement process ➤ Study emission testing and pollution control methods, Observe safety measures followed in the workshop ➤ Interact with technicians regarding maintenance schedules , Prepare a report on service station operations and observations Exemplars / Utility: Automobiles			
Experiment No.10	Dryness fraction of steam	COs Mapped CO1	02 Hrs.
Objective: To determine of dryness fraction of steam using combined separating and throttling calorimeter Associated task: The separating calorimeter mechanically separates water particles from steam. It provides partially dry steam. The throttling calorimeter then superheats the partially dry steam by allowing it to expand through a throttling process (constant enthalpy) and measures the temperature and pressure of the superheated steam. Following are the steps to be completed. ➤ Measure the pressure of steam before throttling & after throttling, temperature of throttled steam. ➤ Collect and measure the mass of separated water & the mass of throttled steam condensate. ➤ Ensure steady stream flow through the calorimeter, Record all experimental observations systematically. ➤ Determine enthalpy of steam before and after throttling using steam tables. ➤ Calculate dryness fraction of steam passing through the throttling calorimeter, dryness fraction considering the separating calorimeter readings. ➤ Determine the overall dryness fraction of steam Exemplars/Practical Applications: In food industries for separating fatty acids from mixtures. For removing organic contaminants.			
Experiment No.11	Determination of Major and Minor Losses in Drip Irrigation system	COs Mapped CO3	02 Hrs.
Objective: To determine the friction factor for flow through Drip irrigation pipes and to evaluate the head losses caused by minor losses in pipe flow. Associated task: ➤ Measure the frictional pressure drop (major loss) per unit length of a drip lateral pipe under varying flow rates.			



- Quantify the cumulative pressure loss caused by inline/online emitters (minor loss) along a lateral.
- Determine the loss coefficient (K) for common drip system fittings (elbows, tees, reducers, valves).

Exemplars/Practical Applications: Determining Maximum Lateral Length for Uniform Irrigation. Diagnosing Poor Performance in an Existing Drip System. Selecting the Right Emitter Type for Sloped Fields
These exemplars transform a standard hydraulic lab exercise into a decision-support tool for irrigation system designers, farmers, and extension officers. Each exemplar can be used as a case study in training programs.

Important Note:

1. Experiment no.1, 2 and 09 are compulsory.
2. Perform any 2 Experiments from 3 to 5 and
3. Perform any 3 Experiments from 6 to 11

Textbooks:

1. P. K. Nag, "Engineering Thermodynamics", Tata McGraw Hill Publications.
2. R. K. Rajput, "Engineering Thermodynamics", EVSS Thermo, Laxmi Publications.
3. P. L. Ballaney, "Thermal Engineering", Khanna Publishers.
4. V. Ganesan, "Internal Combustion Engines", Tata McGraw-Hill.
5. M. L. Mathur and R.P. Sharma, "A course in Internal combustion engines", Dhanpat Rai & Co.
6. Modi P. N. and Seth S. M, "Hydraulics and Fluid Mechanics", Standard Book

Reference Books:

1. Cengel and Boles, "Thermodynamics an Engineering Approach", McGraw Hill.
2. Holman J.P., "Thermodynamics", McGraw Hill.
3. Domkundwar & Domkundwar, "Internal Combustion Engine", Dhanpat Rai & Co.
4. R. Yadav, "Internal Combustion Engine", Central Book Depot, Ahmedabad.
5. Kundu, Cohen, Dowling, "Fluid Mechanics", Elsevier India
6. Chaim Gutfinger David Pnueli, "Fluid Mechanics" Cambridge University press

Virtual Lab, related open source/ subscription based software, Links or websites for lab conduction, animation, simulation etc., e-learning.

1. <https://nptel.ac.in/courses/112105275>
2. <https://nptel.ac.in/courses/112104118>
3. <https://archive.nptel.ac.in/courses/112/103/112103316/>

CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	3	2	1	1	1	1	2	1	1	2	—
CO2	3	3	2	3	2	1	1	1	1	2	1	1	3	—
CO3	3	3	2	3	2	1	1	1	1	2	1	1	3	—
CO4	3	3	1	3	2	1	1	1	1	2	1	1	3	—
CO5	2	2	1	2	2	2	2	2	3	3	2	1	3	1
Avg.	2.8	2.6	1.4	2.8	2.0	1.2	1.2	1.2	1.4	2.2	1.2	1	2.8	—

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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Assessment Pattern

BT Level	Exp. 1	Exp. 2	Exp. 3	Exp. 4	Exp. 5	Exp. 6	Exp. 7	Exp. 8	Exp. 9	Exp. 10
CO	CO1	CO4	CO3	CO3	CO4	CO2	CO2	CO2	CO5	CO1
L1										
L2										
L3	5	5	5	5	5	5	5	5	5	5
L4										
L5										
L6										

This course serves as a **prerequisite for / maps with** the following future courses:

- Heat Transfer
- Refrigeration and Air Conditioning
- Turbo Machines
- Power Plant Engineering
- Automobile Engineering
- Advanced Internal Combustion Engines
- Computational Fluid Dynamics (CFD)
- Hydraulic Machines and Systems
- Energy Engineering
- Thermal Engineering Design
- Industrial Fluid Power Systems

Job Mapping: Job opportunities that one can get after learning this course:

- Thermal Design Engineer
- HVAC Engineer
- Power Plant Engineer
- Energy Analyst
- Boiler Operation Engineer
- Thermal Systems Engineer

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Program:	S. Y. B. Tech (Mechanical Engineering)	Semester:	IV
Course:	Green Technologies and Sustainable Development	Course Code:	R-25-ME-VEC-221/VEC
Teaching Scheme			
Lecture	Practical	Tutorial	Credit
02	--	--	2

Examination Scheme**CCE****ESE****TW****PR****50****--****--****--****Course Description and Relevance:**

Green Technologies and Sustainable Development is a foundational course designed for Second Year Mechanical Engineering students to introduce the principles of environmentally sustainable technologies and engineering practices. The course covers topics such as renewable and clean energy systems, energy conservation, pollution control, waste management, green manufacturing, sustainable materials, and environmental management. It focuses on the application of sustainable engineering concepts in mechanical engineering industries for efficient utilization of resources and reduction of environmental impact.

Mechanical Engineers play a significant role in developing energy-efficient machines, sustainable manufacturing systems, renewable energy technologies, and environmentally responsible industrial processes. With increasing concerns related to climate change, pollution, energy demand, and depletion of natural resources, industries are adopting green technologies and sustainable development practices worldwide. This course helps second year mechanical engineering students understand the importance of sustainable engineering solutions and prepares them to contribute toward environmental protection, industrial sustainability, energy conservation, and future green technology advancements in their professional careers.

Prerequisite:

1. Engineering Physics/Chemistry/Biology
2. Basic Mechanical Engineering
3. Environmental Science / Environmental Studies
4. Engineering Thermodynamics

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

1. **Understand** the fundamentals of sustainability and green technologies.
2. **Learn** renewable and clean energy systems.
3. **Understand** waste management and pollution control techniques.
4. **Apply** sustainable engineering concepts in mechanical engineering.
5. **Develop** awareness regarding environmental protection and sustainable industrial practices.

Course Outcomes: After learning the course, students will be able to

CO	Course Outcome	Bloom's Level
CO1	Understand fundamentals of green technologies and sustainability.	2
CO2	Describe renewable energy systems and clean energy technologies.	2
CO3	Understand pollution control and waste management methods.	2
CO4	Apply energy conservation and green manufacturing concepts.	3
CO5	Analyze sustainable engineering solutions for environmental protection.	4

Course Content

Unit 1	Introduction to Green Technologies	4 Hrs.	COs Mapped CO1, CO2
Environmental issues and climate change, Carbon footprint and ecological footprint, Sustainable development and SDGs, Concept and importance of green technologies, Green engineering principles, Role of mechanical engineers in environmental protection. Exemplars / Practical Applications and usage: Technology designed to reduce environmental damage and conserve natural resources – Find areas where we can Minimize waste.			
Unit 2	Renewable and Clean Energy Technologies	4 Hrs.	COs Mapped CO2



Conventional and non-conventional energy sources ,Solar energy systems and applications ,Wind energy systems Biomass and biogas technologies, Hydrogen energy and fuel cells, Energy conservation and energy efficiency techniques.-e-mobility			
Exemplars / Practical Applications and usage: Smart classroom lighting sensor based.			
Unit 3	Pollution Control and Waste Management	4 Hrs.	COs Mapped CO3
Air pollution and control methods, Water pollution and wastewater treatment basics, Solid waste management Industrial waste management, Recycling and reuse technologies, E-waste management and circular economy concepts.			
Exemplars / Practical Applications and usage: Study of Recycling and reuse technologies Industry- Eg.Ravalyu Ltd.Nashik			
Unit 4	Green Manufacturing and Sustainable Practices	4 Hrs.	COs Mapped CO4
Green manufacturing concepts ,Cleaner production techniques, Sustainable materials and eco-friendly products, Life Cycle Assessment (LCA), Green buildings and sustainable transportation ,Environmental Impact Assessment (EIA), ISO 14001 and environmental management systems			
Exemplars / Practical Applications and usage: Use of Sustainable materials and eco-friendly products. Eg.Shri Ganesh Murthi Making Camp, Use of cow dung for Organic farming.			
Unit 5	Case Studies of Green Technology and Sustainable Industries	4 Hrs.	COs Mapped CO5
Indian Railways – Green Transportation System Tata Steel – Sustainable Steel Manufacturing Suzlon Energy – Wind Energy Development ITC Limited – Sustainable Industrial Practices			
Exemplars / Practical Applications and usage: Case study of Green Manufacturing in Automobile Industry Eg. Tata Motors, Case study of Electric Vehicle (EV) Technology industry Eg. Mahindra Electric			
Comprehensive Continuous Evaluation (CCE) components for the course: Total - 50 Marks			
CCE Evaluation of each unit for 10 Marks			
1. Online quiz on Green Technologies and Sustainability 2. Written Assessment on Renewable Energy and Energy Conservation 3. Group Presentation on Waste Management, Recycling, Pollution Control 4. Skill-Based Activities on Sustainable materials and eco-friendly products 5. Case Study on Indian Automotive industries.			
Textbooks:			
1. P. D. Sharma; Ecology and Environment; Volume 22 of Popular Biology Text Books Rastogi Publications, 2007 2. D.D. Mishra-Fundamental of Environmental Studies, S Chand & Co Ltd (1 December 2010). 3. M. Dayal- Renewable Energy; Environment and Development, Konark Pub.Pvt.Ltd. 4. Fulekar; Fundamental of Air pollution. 4th Edition, Daniel Vallero, Academic Press, Elsevier 5. Ambasht R.S.; Environment and Pollution: An Ecological Approach, CBS Publishers & Distributors; 1st Ed. edition 2014			
Reference Books:			
1. Stanley E. Manahan; Fundamentals of Environmental Chemistry; Publisher: CRC Press 1993 2. E.D. Enger, B. E. Smith; Environmental Sciences-A study of Inter relationships, WCB Publication. 3. Kathy Wilson Peacock; Natural Resources and Sustainable Development. 4. Elizabeth Berner, Robert Berner; Global Enviroment - Water, Air, and Geochemical Cycles, 5. Princeton University Press; 2nd Revised edition edition 2012.			



6. Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill, 2000.
7. Andrew Dessler, Introduction to Modern Climate Change, 2nd Edition, Cambridge University Press, 2015.
8. Bruce Glavovic, Mick Kelly, Robert Kay, Ailbhe Travers, Climate Change and the Coast: Building Resilient Communities, CRC Press, 2015.

MOOCs Links and additional reading material:

1. Ministry of New and Renewable Energy (MNRE) <https://mnre.gov.in/en/>
2. United Nations Sustainable Development Goals <https://www.undp.org/sustainable-development-goals>
3. Bureau of Energy Efficiency (BEE) <https://www.beeindia.gov.in/>
4. Introduction to Environmental Engineering and Science - Fundamental and Sustainability Concepts.(IIT Kharagpur) Link: https://onlinecourses.nptel.ac.in/noc26_ge27/preview
5. Council on Energy, Environment and Water <https://www.ceew.in/>

CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1				2	3	2		1			1	
CO2	2	2	1		1	2	3						1	
CO3	1	2		1		3	3	2					1	
CO4	2	2	2	1	2	2	3		1		1		1	
CO5	2	2	1	1	1	3	3	2	1	1	1		1	1
Avg.	1.8	1.8	1.33	1	1.33	2.4	3	2	1	1	1	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Unit wise Weightage:

Exam	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
CCE	10	10	10	10	10
CT	-	-	-	-	-
ESE	-	-	-	-	-
Total	50				

Assessment Pattern

BT Level	CCE						ESE				
	CCE1	CCE2	CCE3	CCE4	CCE5						
CO	CO1	CO2	CO3	CO4	CO5		CO1	CO2	CO3	CO4	CO5
L1	L1	L1	L1	L1	L1		--	--	--	--	--
L2	-	L2	L2	L2	L2		--	--	--	--	--
L3	-	-	L3	L3	L3		--	--	--	--	--
L4	-	-	-	L4	L4		--	--	--	--	--
L5	-	-	-	-	L5		--	--	--	--	--
L6	-	-	-	-	-		--	--	--	--	--

Amrutvahini

R. Gaurav