SRI VENKATESWARA COLLEGE OF ENGINEERING

(An Autonomous Institution, Affiliated to Anna University, Chennai – 600 025)

B.E. Mechanical and Automation Engineering

CURRICULUM AND SYLLABUS

REGULATION – 2022

CHOICE BASED CREDIT SYSTEM

Curriculum Revision No.	**00**	Board of Studies recommendation date	**06.10.2022 & 12.04.2023**	Academic Council Approved date	**08.10.2022 & 21.04.2023**
Salient Points of the revision	1	Not Applicable – New Program			
	2				
	3				
	4				
	5				

SRI VENKATESWARA COLLEGE OF ENGINEERING

(An Autonomous Institution, Affiliated to Anna University, Chennai – 600 025)

REGULATIONS 2022

CHOICE BASED CREDIT SYSTEM

B.E. MECHANICAL AND AUTOMATION ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

1. Secure professional career in mechanical industries, government, and defense sectors.
2. Offer solutions to problems associated with robotics and automation systems by effectively employing computational and analytical tools.
3. Advance their professional knowledge and expertise by pursuing higher education and lifelong learning.
4. Become job creators and global contributors by taking up entrepreneurship in the field of mechanical and automation engineering.

PROGRAM OUTCOMES (POs)

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
9. **Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

1. Apply domain knowledge of mathematics and mechanical engineering concepts to provide solutions for current industrial challenges.
2. Model, programme and build robotics and automation systems that are cost effective, environment friendly and productive to solve industrial and societal problems using advanced tools and techniques.

PEO's–PO's & PSO's MAPPING:

POs	PEOs			
	I	II	III	IV
1	✓	✓	✓	✓
2	✓	✓	✓	
3	✓	✓	✓	
4			✓	
5		✓	✓	
6		✓	✓	
7			✓	
8			✓	
9			✓	
10	✓	✓	✓	✓
11			✓	
12				
PSOs				
1	✓	✓		
2	✓	✓	✓	

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REGULATIONS 2022

CHOICE BASED CREDIT SYSTEM

B.E. MECHANICAL AND AUTOMATION ENGINEERING

CURRICULUM

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS	PREREQUISITE	POSITION
				L	T	P	C			
1.	IP22151	Induction Program **(Common to all Branches)**	-	-	-	-	-	-	-	-
Theory Courses										
2.	HS22151	Tamil Language and Heritage of Ancient Tamil Society **(Common to all Branches)**	HS	1	0	0	1	1	Nil	F
3.	HS22152	Communicative English **(Common to all Branches)**	HS	3	0	0	3	3	Nil	F
4.	MA22151	Applied Mathematics – I **(Common to all Branches except MR)**	BS	3	1	0	4	4	Nil	F
5.	PH22152	Engineering Physics **(Common to AE, CE, ME, MN, MR)**	BS	3	0	0	3	3	Nil	F
6.	CY22152	Engineering Chemistry **(Common to AE, ME, MN)**	BS	3	0	0	3	3	Nil	F
7.	CS22151	Programming in C **(Common to ME and MN)**	ES	3	0	0	3	3	Nil	F
8.	ME22101	Engineering drawing **(Common to ME, MN, MR)**	ES	2	1	0	3	4	Nil	F
Practical Courses										
9.	PH22161	Physics Laboratory **(Common to all Branches except BT)**	BS	0	0	2	1	2	Nil	F
10.	CY22161	Chemistry Laboratory **(Common to all Branches except AD, CS, IT)**	BS	0	0	2	1	2	Nil	F
11.	CS22161	Programming in C Laboratory **(Common to ME and MN)**	ES	0	0	3	1.5	3	Nil	F
Total				**18**	**1**	**9**	**23.5**	**28**		

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS	PREREQUISITE	POSITION
				L	T	P	C			
Theory Courses										
1.	HS22251	Science and Technology in Ancient Tamil Society **(Common to all Branches)**	HS	2	0	0	2	2	Nil	F
2.	HS22252	Technical English **(Common to all Branches)**	HS	3	0	0	3	3	Nil	F
3.	MA22251	Applied Mathematics – II **(Common to all Branches except MR)**	BS	3	1	0	4	4	Nil	F
4.	PH22253	Engineering Materials **(Common to AE, ME, MN)**	BS	3	0	0	3	3	Nil	F
5.	ME22201	Engineering Mechanics **(Common to ME, MN, MR)**	ES	2	1	0	3	3	Nil	F
6.	EE22151	Basic Electrical and Electronics Engineering **(Common to all Branches except CH, EE, EC)**	ES	3	0	0	3	3	Nil	F
Practical Courses										
7.	ME22211	Production Drawing Laboratory **(Common to ME and MN)**	ES	0	0	4	2	4	Nil	F
8.	EE22111	Basic Electrical and Electronics Engineering Laboratory **(Common to all Branches except EC)**	ES	0	0	2	1	2	Nil	F
Total				**16**	**2**	**6**	**21**	**24**		

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS	PREREQUISITE	POSITION
				L	T	P	C			
Theory Courses										
1.	MA22355	Partial Differential Equations and Numerical Methods **(Common to AE, BT and MN)**	BS	3	1	0	4	4	Nil	F
2.	MN22301	Introduction to Industrial Automation	PC	3	0	0	3	3	Nil	F
3.	ME22302	Mechanics of Materials **(Common to ME and MN)**	PC	2	1	0	3	4	Nil	F
4.	MN22302	Theory of Machines	PC	3	1	0	4	4	Nil	F
5.	MN22303	Manufacturing Technology	PC	3	0	0	3	3	Nil	F
6.	EE22359	Electrical Drives and Controls: Theory and Practices **(Common to ME and MN)**	ES	2	0	2	3	4	Nil	F
Practical Courses										
7.	ME22313	Manufacturing Technology Laboratory	PC	0	0	3	1.5	3	Nil	F
8.	ME22314	Material Testing Laboratory	PC	0	0	3	1.5	3	Nil	F
Total				**16**	**3**	**8**	**23**	**30**		

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS	PREREQUISITE	POSITION
				L	T	P	C			
Theory Courses										
1	GE22451	Environmental Science & Sustainability **(Common to all branches)**	BS	3	0	0	3	3	Nil	F
2	MN22401	Design of Machine Elements	PC	3	1	0	4	4	Nil	F
3	MN22402	Fluid Mechanics and Thermal Science	PC	3	1	0	4	4	Nil	F
4.	MN22403	Operations Research and Management **(Common to ME and MN)**	ES	2	1	0	3	4	Nil	F
5.	MN22408	Hydraulics and Pneumatics for Automation: Theory and Practices **(Common to ME and MN)**	PC	2	0	2	3	3	Nil	F
6.	MN22409	Metrology and Instrumentation: Theory and Practices	PC	2	0	2	3	4	Nil	F
Practical Courses										
7.	ME22411	Computer Aided Modelling Laboratory **(Common to ME and MN)**	PC	0	0	3	1.5	3	Nil	F
8.	ME22412	Fluid and Thermal Engineering Laboratory **(Common to ME and MN)**	PC	0	0	3	1.5	3	Nil	F
Total				**17**	**3**	**11**	**23**	**31**		

SEMESTER V

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS	PREREQUISITE	POSITION
				L	T	P	C			
Theory Courses										
1.	MN22501	Industrial Robotics: Theories for Implementation	PC	3	0	0	3	3	Nil	F
2.	MN22502	Modern Manufacturing Processes	PC	3	0	0	3	3	Nil	F
3.	ME22403	Thermal Engineering **(Common to ME and MN)**	PC	2	1	0	3	3	Nil	F
3.	MN22509	Controllers for Automation: Theory and Practices **(Common to MN and ME)**	PC	2	0	2	3	4	Nil	F
4.	ME22709	Computer Aided Engineering: Theory and Practices **(Common tom ME and MN)**	PC	1	0	4	3	4	Nil	F
5.		PE-I	PE	3	0	0	3	3	Nil	F
6.		Open elective – I	OE	3	0	0	3	3	Nil	F
7.		Mandatory Course	MC	3	0	0	0	3	Nil	M
8.		Value added Course-I	VD	2	0	0	2*	2	Nil	M
Practical Courses										
9.	MN22511	Modern Manufacturing Processes Laboratory	PC	0	0	3	1.5	4	Nil	F
10.	MN22512	Robotics Laboratory	PC	0	0	3	1.5	4	Nil	F
			Total	**22**	**0**	**10**	**24**	**32**		

** Credits earned through the Value-Added Courses shall be over and above the total credit requirement*

SEMESTER VI

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS	PREREQUISITE	POSITION
				L	T	P	C			
Theory Courses										
1.	MN22601	Modern Material Handling Systems **(Common to MN and ME)**	PC	3	0	0	3	3	Nil	F
2.	MN22608	Industrial Internet of Things: Theory and Practices **(Common to MN and ME)**	PC	2	0	2	3	4	Nil	F
3.	MN22609	Programming and Modelling in Industrial Automation: Theory and Practices	PC	1	0	4	3	5	Nil	F
4.		PE-II	PE	3	0	0	3	3	Nil	F
5.		PE-III	PE	3	0	0	3	3	Nil	F
6.		Open Elective-II	OE	3	0	0	3	3	Nil	F
7.		Value added Course-II	VD	2	0	0	2*	2	Nil	M
Practical Courses										
8.	MN22611	Factory Simulation Laboratory	PC	0	0	3	1.5	4	Nil	F
9.	HS22511	Interview and Career Skills Laboratory	EEC	0	0	3	2	3	Nil	F
			Total	**17**	**0**	**13**	**21.5**	**30**		

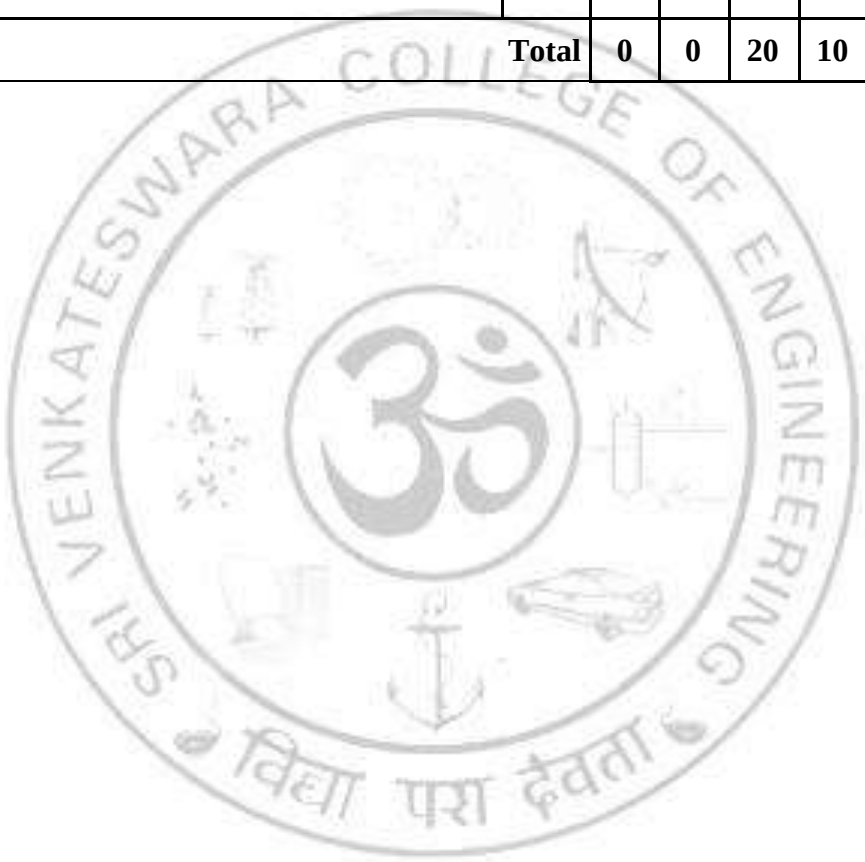
** Credits earned through the Value-Added Courses shall be over and above the total credit requirement*

SEMESTER VII

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS	PREREQUISITE	POSITION
				L	T	P	C			
Theory Courses										
1.	ME22701	Engineering Ethics and Human Values **(Common to ME and MN)**	HS	3	0	0	3	3	Nil	F
2.	MN22701	AI and ML for Automation **(Common to MN and ME)**	PC	3	0	0	3	3	Nil	F
3.	MN22709	Data Science for Industrial Automation: Theory and Practices **(Common to MN and ME)**	PC	2	0	2	3	3	Nil	F
4.		PE-IV	PE	3	0	0	3	3	Nil	M
5.		PE-V	PE	3	0	0	3	3	Nil	M
6.		PE-VI	PE	3	0	0	3	3	Nil	M
Practical Courses										
8.	MN22711	Comprehension	EEC	0	0	2	1	2	Nil	F
9.	MN22712	Industrial Training/Internship	EEC	0	0	0	2	0	Nil	M
			Total	**16**	**0**	**6**	**21**	**21**		

SEMESTER VIII

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS	PREREQUISITE	POSITION
				L	T	P	C			
Theory Courses										
1.	MN22811	Project Work	EEC	0	0	20	10	20	All the courses	F
			Total	**0**	**0**	**20**	**10**	**20**		



VERTICAL 1
SPECIAL ELECTIVE

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS	PREREQUISITE	POSITION
				L	T	P	C			
1.	SE22001	Financial Statement Analysis **(Common to All branches)**	PE	3	0	0	3	3	Nil	-
2.	SE22002	Introduction to Securities Market **(Common to All branches)**	PE	3	0	0	3	3	Nil	-
3.	SE22003	Option Trading Strategies **(Common to All branches)**	PE	3	0	0	3	3	Nil	-
4.	SE22004	Corporate Finance **(Common to All branches)**	PE	3	0	0	3	3	Nil	-
5.	SE22005	Managerial Economics **(Common to All branches)**	PE	3	0	0	3	3	Nil	-
6.	SE22006	Project Management **(Common to All branches)**	PE	3	0	0	3	3	Nil	-
7.	SE22007	Mathematics for AI & ML **(Common to All branches)**	PE	3	0	0	3	3	Nil	-

VERTICAL 2
PRODUCT AND PROCESS DEVELOPMENT

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS	PREREQUISITE	POSITION
				L	T	P	C			
Theory Courses										
1.	ME22021	Design for Manufacturing, Assembly and Environment **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
2.	ME22022	Failure Modes and Effects Analysis **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
3.	ME22023	New Product Development **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
4.	ME22024	Product Life Cycle Management **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
5.	ME22025	Quality and Financial Concepts in Product Development **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
6.	ME22026	System Design for Sustainability **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
7.	ME22027	Value Engineering and Process Planning **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
Practical Courses										
8	ME22020	Product Life Cycle Management Laboratory **(Common to ME and MN)**	PE	0	0	4	2	4	Nil	-
			Total	**18**	**0**	**0**	**23**	**25**		

VERTICAL 3
DIGITAL AND GREEN MANUFACTURING

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS	PREREQUISITE	POSITION
				L	T	P	C			
Theory Courses										
1.	ME22031	Digital Manufacturing and Internet of Things **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
2.	ME22032	Sustainable Manufacturing **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
3.	ME22033	Environmental Impact and Assessment **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
4.	ME22034	Green Manufacturing Design and Practices **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
5.	ME22035	Green Supply Chain Management **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
6.	ME22036	Lean Manufacturing **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
7.	ME22037	Statistical and Quality Techniques for Manufacturing **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
Practical Courses										
8	ME22030	Digital Manufacturing and IoT Laboratory **(Common to ME and MN)**	PE	0	0	4	2	4	Nil	-
			Total	**18**	**0**	**0**	**23**	**25**		

VERTICAL 4

LOGISTICS AND SUPPLY CHAIN MANAGEMENT

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS	PREREQUISITE	POSITION
				L	T	P	C			
Theory Courses										
1.	ME22041	Business Analytics for Management Decision **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
2.	ME22042	Enterprise Resource Planning **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
3.	ME22043	Industrial Engineering and Management **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
4.	ME22044	Logistics in Manufacturing, Supply Chain and Distribution **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
5.	ME22045	Sustainable Supply Chain Management **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
6.	ME22046	Total Quality Management **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
7.	ME22047	Warehousing Automation **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
Practical Courses										
8	ME22040	Project Management Laboratory **(Common to ME and MN)**	PE	0	0	4	2	4	Nil	-
			Total	**18**	**0**	**0**	**23**	**25**		

VERTICAL 5
CLEAN AND GREEN ENERGY TECHNOLOGIES

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS	PREREQUISITE	POSITION
				L	T	P	C			
Theory Courses										
1.	ME22051	Biomass Conversion and Bio-refinery **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
2.	ME22052	Carbon Footprint Estimation and Reduction Techniques **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
3.	ME22053	Energy Conservation and Waste Heat Recovery **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
4.	ME22054	Energy Efficient Buildings **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
5.	ME22055	Energy Storage Devices **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
6.	ME22056	Hydrogen Energy: Production, Storage, Transportation and Safety **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
7.	CH22041	Renewable Energy Resources **(Common to CH, ME,MN and MR)**	PE	3	0	0	3	3	Nil	-
8.	ME22050	Energy Auditing: Case Study **(Common to ME and MN)**	PE	0	0	4	2	4	Nil	-

VERTICAL 6

SMART MANUFACTURING

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS	PREREQUISITE	POSITION
				L	T	P	C			
Theory Courses										
1.	MN22061	Digital Twin and Industry 5.0 **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
2.	MN22062	Drone Technologies **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
3.	MN22063	Industrial Network and Protocol **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
4.	MN22064	Intelligent Physical Systems **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
5.	MN22065	Machine vision and Image processing **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
6.	MN22066	Robot Operating Systems **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
7.	MN22067	Robotics for Smart Manufacturing **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
8.	MN22060	Mini Project** **(Common to ME and MN)**	PE	0	0	4	2	4	Nil	-

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VERTICAL 7

DIVERSIFIED GROUP-1

(Only for MN)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS	PREREQUISITE	POSITION
				L	T	P	C			
Theory Courses										
1.	MN22071	Computational Fluid dynamics: Theory and Practices	PE	2	0	2	3	4	Nil	-
2.	AE22602	Electric and Hybrid Vehicles **(Common to AE, ME and MN)**	PE	3	0	0	3	3	Nil	-
3.	MN22072	Nanotechnology	PE	3	0	0	3	3	Nil	-
4.	MN22073	Non-Destructive Testing	PE	3	0	0	3	3	Nil	-
5.	MN22074	Production Planning and Control	PE	3	0	0	3	3	Nil	-
6.	MN22075	Smart and Bio Materials **(Common to MN and ME)**	PE	3	0	0	3	3	Nil	-
7.	MN22076	Welding Technology	PE	3	0	0	3	3	Nil	-
8.	MN22077	Introduction to Heat Transfer	PE	2	1	0	3	3	Nil	-

VERTICAL 8

DIVERSIFIED GROUP-2
(Common to ME & MN)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS	PREREQUISITE	POSITION
				L	T	P	C			
Theory Courses										
1.	ME22081	Automobile Engineering **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
2.	ME22082	Composite Materials and Mechanics **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
3.	ME22083	Heating, Ventilation and Air-Conditioning Systems **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
4.	ME22084	Industrial Safety Engineering **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
5.	ME22085	Instrumentation and Control Systems **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
6.	ME22086	Power Plant Engineering **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-
7.	ME22087	Principles of Management **(Common to ME, AE, EE, IT and MN)**	PE	3	0	0	3	3	Nil	-
8.	ME22088	Vibrations and Noise Control **(Common to ME and MN)**	PE	3	0	0	3	3	Nil	-

OPEN ELECTIVE COURSES
(OFFERED BY THE MECHANICAL DEPARTMENT DURING ODD SEMESTER)

	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS
				L	T	P	C	
1.	OE22002	3D Printing and Design: Theory and Practices	OE	2	0	2	3	4
2.	OE22003	Lean Six Sigma	OE	3	0	0	3	3

OPEN ELECTIVE COURSES
(OFFERED BY THE MECHANICAL DEPARTMENT DURING ODD SEMESTER)

	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS
				L	T	P	C	
3.	OE22004	Robotics and Programming: Theory and Practices	OE	2	0	2	3	4
4.	OE22001	Green Manufacturing	OE	3	0	0	3	3

MANDATORY COURSES

	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS
				L	T	P	C	
1.	MC22001	Indian Constitution **(Common to all Branches except MR)**	MC	3	0	0	0	3
2.	MC22002	Essence of Indian Traditional Knowledge **(Common to all branches)**	MC	3	0	0	0	3
3	MC22003	Gender Sensitization **(Common to all branches)**	MC	3	0	0	0	3
4	GN22001	Introduction to NCC for Engineers **(Common to all branches)**	MC	2	0	2	0	2
5	GN22002	Yoga and Physical Culture **(Common to all branches)**	MC	0	0	2	0	2
6	GN22003	Introduction to Fine Arts **(Common to all branches)**	MC	2	0	0	0	2

Value Added Courses
(To be completed between III and VI Semesters)

	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS
				L	T	P	C	
1.	VD22001	Advanced Gear Manufacturing Concepts	VA	2	0	0	0	2
2.	VD22002	Condition Monitoring of Machine Tools	VA	2	0	0	0	2
3.	VD22003	Design and Development of Press Tools	VA	2	0	0	0	2
4.	VD22004	Engine Instrumentation and Testing	VA	2	0	0	0	2
5.	VD22005	Geometrical Dimensioning and Tolerance	VA	2	0	0	0	2
6.	VD22006	Kaizen and its Applications	VA	2	0	0	0	2
7.	VD22007	Kinematic Analysis of Mechanical Links	VA	2	0	0	0	2
8.	VC22001	Basics of Entrepreneurship Development **(Common toAll Branches)**	VA	2	0	0	0	2
9.	VC22002	Advances in Entrepreneurship Development **(Common toAll Branches)**	VA	2	0	0	0	2
10.	VC22003	Communicative German **(Common to all Branches except MR)**	VA	2	0	0	0	2
11.	VC22004	Communicative Hindi **(Common to all Branches except MR)**	VA	2	0	0	0	2
12.	VC22005	Communicative Japanese **(Common to all Branches except MR)**	VA	2	0	0	0	2
13.	VC22006	Design Thinking and Prototyping Laboratory **(Common to All Branches)**	VA	2	0	0	0	2

SUMMERY

SL. NO.	CATEGORY	CREDITS IN SEMESTER								Total Credits
		I	II	III	IV	V	VI	VII	VIII	
1	Humanities and Social Sciences including Management courses (HS)	4	5					3		12
2	Basic Science courses (BS)	12	7	4						23
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc., (ES)	7.5	9	3	3					22.5
4	Professional Core courses (PC)			16	20	13	12	9		69
5	Professional Elective courses relevant to chosen specialization/branch (PE)					6	6	6		18
6	Open Elective subjects - Electives from other technical and /or emerging subjects (OE)					3	3			6
7	Project work, seminar, and internship in industry or elsewhere (EEC)						1.5	3	10	14.5
8	Mandatory Courses (MC)					0				
	Semester wise Total	**23.5**	**21**	**23**	**23**	**24**	**21.5**	**21**	**10**	**167**

SEMESTER I

HS22151	**தமிழ் மொழியும் தமிழர் மரபும்** **Tamil Language and Heritage of Ancient Tamil Society** **(Common to all Branches)**	**L**	**T**	**P**	**C**
		1	**0**	**0**	**1**

பாடத்தின் நோக்கங்கள்:

1.	தமிழ் மொழியின் தோற்றம் பற்றியும், திணை கருத்துக்கள் வாயிலாக வாழ்வியல் முறைகளை பற்றியும் கற்றுக் கொள்வார்கள்.
2.	இந்திய தேசிய சுதந்திர இயக்கத்தில் தமிழர்களின் பங்களிப்பு மற்றும் தமிழர்களின் மேலாண்மை முறைகளை பற்றியும் கற்றுக் கொள்வார்கள்.

அலகு 1	**தமிழுக்கும் தொழில் நுட்ப கல்விக்கும் உள்ள தொடர்பு**	**3**

மொழி மற்றும் பாரம்பரியம்: இந்தியாவில் உள்ள மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழில் செம்மொழி இலக்கியம் - உ.வே. சுவாமிநாத ஐயர்., ஆறுமுக நாவலர் ஆகியோரின் பங்களிப்பு - தொழில் நுட்ப கல்வியில் தமிழ் மொழிக் கல்வியின் முக்கியத்துவம்.

LANGUAGE AND HERITAGE: Language families in India – Dravidan Languages – Tamil as a Classical language – Classical Literature in Tamil – Contribution of U. Ve. Saminathaiyar. Arumuka Navalar – Importance of Tamil language in technical education.

அலகு 2	**திணை கருத்துக்கள்**	**9**

திணை கருத்துக்கள்: ஐந்து வகை நிலங்கள், தமிழர்களின் தாவரங்கள் மற்றும் விலங்கினங்கள், கடவுள்கள், தொழில்கள் , வாழ்க்கை முறை, பண் , கூத்து , உணவு முறை - தொல்காப்பியம் மற்றும் சங்க இலக்கியங்களில் இருந்து அகம் மற்றும் புறம் கருத்து - தமிழ் அறம் கருத்து - சங்க காலத்தில் கல்வி மற்றும் எழுத்தறிவு - பண்டைய நகரங்கள் மற்றும் சங்க காலத்தில் துறைமுகங்கள் - சங்க காலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி - சோழ மன்னர்களின் வெளிநாட்டு வெற்றிகள்.

THINAI CONCEPTS: Five types of lands, animals, Gods, occupation, life styles, music, dance , food style, Floara and Fauna of Tamils - Agam and puram concept from Tholkappiyam and Sangam Literature – Aram concept of Tamil – Education and Literacy during Sangam Age – Ancient cities and Ports of Sangam Age – Export and Import during Sangam Age - Overseas Conquest of Choloas.

அலகு 3	**தமிழரின் மரபு**	3

இந்திய தேசிய சுதந்திர இயக்கம் மற்றும் இந்திய கலாச்சாரத்திற்கு தமிழர்களின் பங்களிப்பு: சுப்ரமணிய பாரதி, வாஞ்சிநாதன், சுப்பிரமணிய சிவா, வீரபாண்டிய கட்டபொம்மன், வா.. ஊ சிதம்பரம் பிள்ளை, தீரன் சின்னமலை, மருது பாண்டிய சகோதரர்கள், பூலி தேவர், திருப்பூர் குமரன், வீர மங்கை வேலுநாச்சியார் - தமிழர் இலக்கியங்களில் மேலாண்மை **கருத்துக்கள் (கி. மு. 500 முதல் கி. பி 200 வரை)** – அகநானூறு, புறநானூறு, திருக்குறள் ஆகியவற்றில் மேலாண்மைக் கருத்துகள்..

Contribution of Tamils to Indian National Freedom Movement and Indian Culture: Contributions of Subramanya Bharathi, Vanchinathan, Subramaniya Siva, Veerapandiya Kattabomman, V O Chidambaram Pillai, Dheeran Chinnamalai, The Maruthu Pandiyar, Puli Thevar, Tiruppur Kumaran, Veera Mangai Velunachiyar.	
மொத்தம்: **15 காலங்கள்**	
பா .வெ . எண்	**பாடத்திட்டத்தின் வெளிப்பாடு**
CO1	மாணவர்கள் தமிழ் மொழி தோற்றம் பற்றி தெரிந்து கொள்வார்கள்
CO2	தமிழர்களின் வாழ்வியல் முறைகளை தெரிந்து கொள்வார்கள்
CO3	தமிழர்களின் சுதந்திர போராட்ட வீரர்களை பற்றியும், மேலாண்மை முறைகளை பற்றியும் தெரிந்து கொள்வார்கள்
பாட நூல்கள்:	
1.	பொன். முத்துகுமாரன் (2002), **"தமிழ் மரபு",** காந்தளகம், 68, அண்ணா சாலை, சென்னை 600 002.
2.	பி. டி ஸ்ரீனிவாச ஐயங்கார் ***(தமிழக்கமும் திறனாய்வும்)*** புலவர் கா. கோவிந்தன் (1988), "**தமிழர் வரலாறு (முதல் பகுதி)**", திருநெல்வேலி தென்னிந்திய சைவ சித்தாந்த நூற்பதிப்பு கழகம் ,154, TTK சாலை, சென்னை 18.
3.	டாக்டர் கே கே பிள்ளை (2009), **"தமிழக வரலாறு மக்களும் பண்பாடும்**", உலக தமிழாராய்ச்சி நிறுவனம், தரமணி , சென்னை 600113.
4.	முனைவர். ச. இராஜேந்திரன் (2004), "**தமிழில் சொல்லாக்கம்**", தஞ்சாவூர் தமிழ் பல்கலைக் கழகம் வெளியீடு.

HS22152	COMMUNICATIVE ENGLISH (Common to all Branches)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	Enable learners to interact fluently on everyday social contexts.
2.	Train learners to engage in conversations in an academic/scholarly setting.
3.	Instill confidence in learners to overcome public speaking barriers.
4.	Develop learners' ability to take notes and in the process, improve their listening skills
5.	Enhance learners' reading skill through reading text passages for comprehension and contemplation.
6.	Improve learners' skills to write on topics of general interest and drafting correspondences for general purposes

UNIT I **9**

Listening - short video clips - conversational scenes form movies, celebrities' speeches/interviews. Speaking - several ways of introducing oneself at several situations, introducing others at several situations, inviting people for several occasions, describing people and their places. Reading - short comprehension passages - making inferences, critical analysis. Writing - completing the incomplete sentences - developing hints from the given information. Grammar - Why-Questions and Yes or No questions - Parts of speech. Vocabulary development - prefixes - suffixes - articles - countable / uncountable nouns.

UNIT II **9**

Listening - customer care voice files, short narratives - identifying problems and developing telephone etiquettes. Speaking - speaking over skype/WhatsApp, making business calls, making self- recorded informative videos, inquiring about a concept/activity, describing a concept/activity. Reading - reading the headlines on news magazines - slogans and taglines from advertisements. Writing - free writing - writing - headlines, slogans and taglines individual inspirations. Grammar - conjunctions, idioms, phrases, quotes. Vocabulary development - guessing the meanings of words in various different contexts

UNIT III **9**

Listening - courtroom scenes from movies, debates and talks from news channels, notes taking. Speaking - language and tone for arguments, discussion, deliberation, contemplation, expressing opinions, reacting to different situations in an alien country. Reading - language used in instruction manuals of household appliances, cookery and other basic instructions. Writing- understanding the structure of texts - use of reference words, discourse markers-coherence, rearranging the jumbled sentences. Grammar - adjectives - degrees of comparison, framing direct and indirect questions. Vocabulary development - concise approach, single word substitution.

UNIT IV **9**

Listening - Sports commentaries, advertisements with users' criticisms; Speaking - for social causes, for promoting a concept, negotiating and bargaining; Reading - review of a product, movie, movement or a system; Writing - writing for advertisements, selling a product; Grammar - Tenses - Simple Past, Present and Future, Continuous - Past, Present and Future; Vocabulary Development - synonyms, antonyms and phrasal verbs.

UNIT V **9**

Listening - video lectures, video demonstration of a concept; Speaking - presenting papers/concepts, delivering short speeches, discourses on health, suggesting natural home remedies, cleanliness, civic

sense and responsibilities; Reading - columns and articles on home science; Writing - correspondences of requests, basic enquiry/observation and basic complaints; Grammar - modal verbs, perfect tenses - Vocabulary development - collocations.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Acquire** adequate vocabulary for effective communication	3
CO2	**Listen** to formal and informal communication and read articles and infer meanings from specific contexts from magazines and newspapers.	3
CO3	**Participate** effectively in informal/casual conversations; introduce themselves and their friends and express opinions in English.	4
CO4	**Comprehend** conversations and short talks delivered in English.	6
CO5	**Write** short write-ups and personal letters and emails in English	6

REFERENCES:

1.	Department of English, Anna University, "Mindscapes: English for Technologists and Engineers". Orient Black Swan, Chennai, 2017.
2.	Downes, Colm, "Cambridge English for Job-hunting", Cambridge University Press, New Delhi. 2008.
3.	Murphy, Raymond, "Intermediate English Grammar with Answers", Cambridge University Press 2000.
4.	Thomson, A.J., "Practical English Grammar 1 & 2", Oxford, 1986.

E-RESOURCES:

1.	http://www.usingenglish.com
2.	http://www.uefap.com3
3.	https://owl.english.purdue.edu/owl/
4.	www.learnenglishfeelgood.com/esl-printables-worksheets.html

SOFTWARE:

1.	Face2Face Advance – Cambridge University Press, 2014
2.	English Advance Vocabulary- Cambridge University Press
3.	IELTS test preparation – Cambridge University Press 2017
4.	Official Guide to the TOEFL Test With CD-ROM, 4th Edition
5.	CAMBRIDGE Preparation for the TOEFL TEST- Cambridge University Press, 2017

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1										3				

2										3				
3										3				
4										3				
5										3				
1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)														

MA2215 1	APPLIED MATHEMATICS I (Common to all Branches except MR)	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

1.	Compute Eigen values and Eigen vectors and use in diagonalization and in classifying real quadratic forms.
2.	Study differential calculus and its applications to relevant Engineering problems.
3.	Compute derivatives using the chain rule or total differentials.
4.	Understand the rotation of two-dimensional geometry using definite integrals.
5.	Acquaint with the Mathematical tools needed in evaluating multiple integrals and their usage.

UNIT I	MATRICES	12

Eigen values and Eigen vectors of a real matrix - Characteristic equation - Properties of Eigen values and Eigen vectors - Statement and Applications of Cayley-Hamilton Theorem - Diagonalization of matrices - Reduction of a quadratic form into canonical form by orthogonal transformation - Nature of quadratic forms.

UNIT II	APPLICATION OF DIFFERENTIAL CALCULUS	12

Curvature and radius of Curvature - Centre curvature - Circle of curvature - Evolutes - Envelopes - Evolute as Envelope of Normals.

UNIT III	DIFFERENTIAL CALCULUS FOR SEVERAL VARIABLES	12

Limits and Continuity - Partial derivatives - Total derivatives - Differentiation of implicit functions - Jacobians and properties - Taylor's series for functions of two variables - Maxima and Minima of functions of two variables - Lagrange's method of undetermined multipliers.

UNIT IV	APPLICATION OF DEFINTE INTEGRALS	12

Integration by Parts - Bernoulli's formula for integration - Definite integrals and its Properties - Solids of Revolution - Disk Method - Washer Method- Rotation about both x and y axis and Shell method.

UNIT V	MULTIPLE INTEGRALS	12

Double integrals in Cartesian and polar coordinates - Change of order of integration - Area enclosed by plane curves - Change of variables in double integrals - Triple integrals - Volume of solids.

TOTAL: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Solve** the Eigen value problems in matrices.	**3**
CO2	**Apply** the basic notion of calculus in Engineering problems and to tackle for different geometries.	**3**
CO3	**Perform** calculus for more than one variable and its applications in Engineering problems.	**3**
CO4	**Apply** definite integrals for design of three-dimensional components.	**3**
CO5	**Evaluate** multiple integral in Cartesian and polar coordinates.	**3**

TEXTBOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2018.
2. Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2018

REFERENCES:

1.	Bali. N.P, and Manish Goyal, "A Text book of Engineering Mathematics", Ninth Edition, Laxmi Publications Pvt. Ltd., 2014.
2.	Glyn James, "Advanced Modern Engineering Mathematics", 4th Edition, Pearson Education, 2016.
3.	Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, 2013.

E-RESOURCES:

1.	https://home.iitk.ac.in/~peeyush/102A/Lecture-notes.pdf
2.	https://www.sydney.edu.au/content/dam/students/documents/mathematics-learning-entre/integration-definite-integral.pdf
3.	https://home.iitk.ac.in/~peeyush/102A/Lecture-notes.pdf

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3			2										
2	3	2		2										
3	3	2		2										
4	3			1										
5	3			2										

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

PH22152	ENGINEERING PHYSICS (Common to AE, CE, ME, MN, MR)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To enhance the fundamental knowledge in Physics and its applications relevant to Streams of Engineering.

UNIT I	MECHANICS	9

Moment of inertia (M.I) - Radius of gyration - Theorems of M. I - M.I of circular disc, solid cylinder, hollow cylinder, solid sphere and hollow sphere - K.E of a rotating body - M.I of a diatomic molecule - Rotational energy state of a rigid diatomic molecule - centre of mass - conservation of linear momentum - Relation between Torque and angular momentum - Torsional pendulum.

UNIT II	PROPERTIES OF MATTER AND THERMAL PHYSICS	9

Fluid - definition, distinction between solid and fluid - Units and dimensions - Properties of fluids - density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapour pressure, capillarity and surface tension - Fluid statics: concept of fluid static pressure, absolute and gauge pressures - pressure measurements by manometers-forces on planes - centre of pressure - buoyancy and floatation. Modes of heat transfer - thermal conductivity - Newton's law of cooling - Linear heat flow - Lee's disc method - Radial heat flow - Rubber tube method - conduction through compound media (series and parallel).

UNIT III	ACOUSTICS AND ULTRASONICS	9

Classification of Sound- decibel- Weber–Fechner law - Sabine's formula- derivation using growth and decay method - Absorption Coefficient and its determination –factors affecting Acoustics of buildings and their remedies. Production of Ultrasonics by Magnetostriction and Piezoelectric methods - Acoustic grating - Non-Destructive Testing - pulse echo system through transmission and reflection modes - A, B and C - scan displays, medical applications - Sonogram.

UNIT IV	PHOTONICS AND FIBER OPTICS	9

Photonics: population of energy levels, Einstein's A and B coefficients derivation - resonant cavity, optical amplification (qualitative) - Nd-YAG laser - CO_2 Laser - Applications. Fiber optics: principle, numerical aperture and acceptance angle - types of optical fibres (material, refractive index, and mode) - losses associated with optical fibers - Fiber optic communication - fibre optic sensors: pressure and displacement- Endoscope.

UNIT V	CRYSTAL PHYSICS	9

Single crystalline, polycrystalline and amorphous materials - single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices - interplanar distances - coordination number and packing factor for SC, BCC, FCC, HCP and diamond structure (qualitative) – crystal imperfections: point defects, line defects - Burger vectors, stacking fault.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Gain knowledge in Mechanics	**2**
CO2	Evaluate the concepts of properties of matter and thermal physics.	**3**
CO3	Learn to solve the issues related to defects in the buildings due to acoustic design and the significance of ultrasonic waves.	**3**

CO4	Develop an understanding about photonics and Fiber Optic communication system.	**2**
CO5	Classify and demonstrate the fundamentals of crystals and their defects.	**3**

TEXTBOOKS:

1.	Gaur R.K. and Gupta S.L, "Engineering Physics", Dhanput Publications, 2015.
2.	Shatendra Sharma and Jyotsna Sharma, "Engineering Physics", Pearson, 2006.
3.	Rajendran V, "Engineering Physics", Tata McGraw Hill, 2009.
4.	Arumugam M, "Materials Science", Anuradha Publications, 2015

REFERENCES:

1.	David Halliday, Robert Resnick, Jearl Walker, "Principles of Physics", 10th Edition, Wiley,2015.
2.	Peter Atkins and Julio De Paula, "Physical Chemistry", 10th Edition, Oxford University Press,2014.
3.	Arthur Beiser, Shobhit Mahajan, Rai Choudhury S, "Concepts of Modern Physics", 7th Edition, McGraw Hill Education, 2017.
4.	Raghavan V, "Materials Science and Engineering", PHI Learning Pvt. Ltd., 2010.

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2		2						1			3	2
2	3	2		2						1		2	2	2
3	3		2		3	2	1			1				
4	3		2		3	2	1			1		2	2	2
5	3	2	2							1			1	

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

CY22152	ENGINEERING CHEMISTRY (Common to AE, ME, MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To make the students to understand the importance of electrochemistry.
2.	To appreciate the concepts of photochemistry and spectroscopy.
3.	To impart knowledge on nanotechnology.
4.	To understand the applications of engineering materials.
5.	To familiarize the manufacture of fuels.

UNIT I ELECTROCHEMISTRY **9**

Electrodes and electrochemical cells - electrode potential, standard electrode potential, single electrode potential and its determination, types of electrodes - calomel, quinhydrone and glass electrode. Nernst equation - determination of pH of a solution by using quinhydrone and glass electrode. Electrochemical series and its applications. Batteries - Primary (dry battery) and secondary batteries (Lead - acid storage)

UNIT II PHOTOCHEMISTRY **9**

Laws of photochemistry - Grotthuss-Draper law, Stark-Einstein law and Lambert Beer Law - determination iron by spectrophotometer. Quantum efficiency - Photo physical processes - internal conversion, inter-system crossing, fluorescence, phosphorescence and photo-sensitization-quenching of fluorescence and its kinetics, Stern-Volmer relationship. Applications of photochemistry.

UNIT III NANOCHEMISTRY **9**

Basics and scale of nanotechnology, different classes of nanomaterials, Distinction between molecules, nanoparticles and bulk materials; size-dependent properties. Synthesis of nanomaterials, fabrication (lithography) and its applications - Basics of nanophotonics and quantum confined materials (surface plasmon resonance).

UNIT IV ENGINEERING MATERIALS **9**

Abrasives: definition, classification, grinding wheel, abrasive paper and cloth. Refractories: definition, characteristics, classification, properties - refractoriness and RUL, dimensional stability, thermal spalling, thermal expansion, porosity; Manufacture of alumina, magnesite and silicon carbide, Lubricants – classification, properties and applications. Basics of composite materials, properties and applications.

UNIT V FUELS AND COMBUSTION **9**

Fuel: Introduction - classification of fuels- calorific value - higher and lower calorific values - analysis of coal (proximate and ultimate) - carbonization - manufacture of metallurgical coke (Otto Hoffmann method) - petroleum - refining - manufacture of synthetic petrol (Bergius process)- knocking - octane number - diesel oil - cetane number - natural gas - compressed natural gas (CNG) - liquefied petroleum gases (LPG) - producer gas - water gas. Combustion of fuels: introduction - theoretical calculation of calorific value - calculation of stoichiometry of fuel and air ratio - flue gas analysis (ORSAT Method) - Uses of catalytic converters.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Identify electrochemical cells, corrosion and fundamental aspects of batteries	**2**
CO2	Interpret the photochemical reactions and make use of spectroscopic	**2**

CO3	Realize the structures, properties and applications of nanoparticles.	**2**
CO4	Acquire knowledge on the basic properties of engineering materials and its applications	**2**
CO5	Illustrate the various materials that are important both in industry and domestic	**3**

TEXTBOOKS:

1.	P.C. Jain and Monica Jain, "Engineering Chemistry", Dhanpet Rai & Sons, New Delhi, 17th Edition, 2018.
2.	Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company, Ltd., New Delhi, 2008

REFERENCES:

1.	Ozin G. A. and Arsenault A. C., "Nanochemistry: A Chemical Approach to Nanomaterials", RSC Publishing, 2005.
2.	B.R. Puri, L.R. Sharma, M.S. Pathania., "Principles of Physical Chemistry", 47th edition, Vishal Publishing C., Jalandhar 2018.
3.	P.L. Sony and H.M.Chawla, "Text Book of Organic Chemistry", Sultan Chand and Sons Publishers, New Delhi, 2000.

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2	3								3		
2	3	3				3	3					3		
3	3	3	2			3	3	3				3		
4	3	3		3			3	3				3		
5	3	3		3		3		3				3		

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

CS22151	PROGRAMMING IN C (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	Learn the basics of computers.
2.	Learn the different ways of stating algorithms – step-form, Pseudocode and flow chart
3.	Learn the logical operators and expressions to solve problems in engineering and real-time
4.	Learn about decision type and looping type control constructs in C
5.	Understand to store, manipulate and retrieve data in a single and multidimensional array
6.	Understand about function and its benefits.
7.	Learn to use arrays, strings, functions, pointers, structures, unions and files in C.

UNIT I	INTRODUCTION	9

Number System Conversion, Computer, Evolution of Computers, Anatomy of Computer - Hardware - Software - Data Representation, Memory Unit, Operating Systems, Computer Networks - Basic elements - Data Transmission mode – Data Transmission Media - Network Topology - Network Devices - Communication Networks (LAN,WAN,MAN), Internet – Uses –Advantages – Limitations - Services (Email, FTP, Telnet), Introduction to Programming, Algorithms and Flow Chart.

UNIT II	C PROGRAMMING BASICS	9

Introduction to 'C' programming – Developing program in C, A Simple C Program, Structure of a C program, Concept of a Variable, Data Types in C, Tokens, Operators and Expressions, Type Conversions, Input and Output functions, Control Statements – Conditional Execution and Selection – Iterative and Repetitive Execution – Nested Loops, Solving simple scientific and statistical problems.

UNIT III	ARRAYS AND STRINGS	9

One dimensional Array – Declaration - Initialization of Integer Elements - Accessing Array Elements, Searching and Sorting of array elements, Two dimensional arrays – Declaration - Initialization of Integer Elements - Accessing Array Elements, Addition, Subtraction and Multiplication of two dimensional integer elements, Strings, Arrays of strings, Solve problems with and without using string functions.

UNIT IV	FUNCTIONS AND USER DEFINED DATA TYPES	9

Concept of Function, Using Functions, Mechanism - Call by value, Call by reference, Recursion, - Structures, Unions, Enumerators.

UNIT V	POINTERS AND FILES	9

Understanding Memory Address, Address Operator, Pointers, void Pointer, NULL Pointer, Arrays and Pointers, Pointers arithmetic, Double Pointers, Using Files in C, Working with Text Files, Sequential and Random Access to Files.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Apply various problem-solving techniques and represent solutions in the form of algorithms and flow charts.	2

CO2	Able to write C programs using the control statements of C language for simple	**2**
CO3	Develop programs using of array and string operations to solve problems.	**2**
CO4	Create user-defined functions , structures and unions to perform a task.	**2**
CO5	Use file operations to store and retrieve data	**1**

TEXTBOOKS:

1.	Pradip Dey, Manas Ghosh, "Programming in C", First Edition, Oxford University Press, 2018.

REFERENCES:

1.	Ashok N Kamthane, "Programming in C", Third Edition, Pearson, 2015
2.	Kernighan, B.W and Ritchie, D.M, "The C Programming language", Second Edition, Pearson Education, 2015.
3.	Yashavant P. Kanetkar. "Let Us C", BPB Publications, 2011.
4.	Paul J Deitel, Dr. Harvey M. Deitel, "C How to Program", Seventh Edition, Pearson Education, 2016.

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2	3	3	1							1			
2	1	1	2	1	1									
3	1		2	1										
4	1		2	1										
5	1		2	1										

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

ME22101	ENGINEERING DRAWING (Common to ME, MN, MR)	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

1.	This course will introduce students to build their ability to read drawings and interpret the position and form of simple geometries.

CONCEPTS AND CONVENTIONS AND GEOMETRIC CONSTRUCTION

(Not for Examination)

Importance of drawing in engineering applications - Use of drafting instruments - BIS conventions and specifications - Size, layout and folding of drawing sheets - Lettering and dimensioning. Geometric construction - to draw perpendiculars, parallel lines, divide a line and circle, to draw equilateral triangle, square, regular polygons.

UNIT I	CYCLOIDAL CURVES, INVOLUTE AND PROJECTIONS OF POINTS, LINES	12

Basic construction of cycloid, epicycloid and hypocycloid - Drawing of tangents and normal to the above curves. Construction of involutes of square, pentagon and circle - Drawing of tangents and normal to the above involutes.

Orthographic projection – Introduction to Principal Planes of projections - First angle projection - projection of points. Projections of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method.

UNIT II	PROJECTIONS OF PLANES AND PROJECTIONS OF SOLIDS	12

Projections of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

Projections of regular solids like prisms, pyramids, cylinder, cone when the axis is inclined to one of the principal planes and parallel to the other by rotating object method.

UNIT III	SECTIONS OF SOLIDS AND DEVELOPMENT OF SURFACES	12

Sectioning of regular solids like prisms, pyramids, cylinder and cone in vertical position when the section plane is inclined to one of the principal planes and perpendicular to the other - Drawing of sectional front and top views and true shape of section.

Development of surfaces of simple and sectioned solids - prisms, pyramids cylinders and cones.

UNIT IV	ISOMETRIC PROJECTION AND INTERSECTION OF SURFACES	12

Introduction to Pictorial Projection - Principles of isometric projection - Isometric scale - lsometric projection of regular solids (prisms, pyramids, cylinder, cone), truncated solids and their combination in vertical position.

Line of intersection - Determining the line of intersection between surfaces of two interpenetrating solids with axes of the solids intersecting each other perpendicularly, using line method - Intersection of two square prisms and Intersection of two cylinders are only to be considered.

UNIT V	FREE-HAND SKETCHING	12

Free-hand sketching – Sketching procedures – Steps in sketching - Orthographic views (front, top and side views) of simple blocks from their Isometric view, Isometric view of simple blocks from their Orthographic views (front, top and side views)

TOTAL: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Construct Engineering curves and sketch the orthographic views of lines as per drawing standards	**3**
CO2	Draw orthographic projections of plane surfaces and simple solids in various positions	**3**
CO3	Draw the various views of sectioned solids and develop the lateral surfaces of simple solids.	**3**
CO4	Draw isometric projections of simple solids and their combinations and the orthographic projection of the intersection of surfaces of simple solids.	**3**
CO5	Sketch the orthographic projections of a given isometric view and vice versa using free hand.	**3**

TEXTBOOKS:

1.	Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 53rd Edition, 2019.
2.	Venugopal K. and Prabhu Raja V., "Engineering Drawing AutoCAD", New Age International

REFERENCES:

1.	Basant Agarwal and Agarwal C, "Engineering Drawing", McGraw Hill, 2nd Edition, 2019.
2.	Parthasarathy N. S. and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.
3.	Shah M, and Rana B.C., "Engineering Drawing", Pearson Education, 2nd Edition, 2009.
4.	Natrajan K.V., "A Text Book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2018.

E-RESOURCES:

1.	https://nptel.ac.in/courses/112105294
2.	https://nptel.ac.in/courses/112103019

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	1	2							1		1		
2	3	1	2							2		1		
3	3	1	2							2		1		
4	3	1	2							3		1		
5	3	1	2							3		1		

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

PH22161	PHYSICS LABORATORY (Common to all Branches except BT)	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

1.	To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics and properties of matter.

LIST OF EXPERIMENTS (Any EIGHT experiments)

1.	a) Determination of Wavelength, and particle size using Laser. b) Determination of acceptance angle in an optical fiber.
2.	Determination of velocity of sound and compressibility of liquid - Ultrasonic Interferometer.
3.	Determination of wavelength of mercury spectrum - spectrometer grating.
4.	Determination of thermal conductivity of a bad conductor - Lee's Disc method.
5.	Determination of Young's modulus by Non uniform bending method.
6.	Determination of specific resistance of a given coil of wire - Carey Foster's Bridge.
7.	Determination of Rigidity modulus of a given wire - Torsional Pendulum
8.	Energy band gap of a Semiconductor
9.	Determine the Hysteresis loss of a given Specimen
10.	Calibration of Voltmeter & Ammeter using potentiometer.

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Analyze the physical principle involved in the various instruments; also relate the principle to new application.	**4**
CO2	Comprehend the Experiments in the areas of optics, mechanics and thermal physics to nurture the concepts in all branches of Engineering.	**3**
CO3	Apply the basic concepts of Physical Science to think innovatively and also improve the creative skills that are essential for engineering.	**3**
CO4	Evaluate the process and outcomes of an experiment quantitatively and qualitatively.	**3**
CO5	Extend the scope of an investigation whether results come out as expected.	**3**

REFERENCES:

1.	Physics Laboratory practical manual, 1st Revised Edition by Faculty members, 2018.

COURSE ARTICULATION MATRIX:														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2	3	2				3	1		2	1	1
2	3	3		3		2			3	1		2	1	1
3	3	3	2	3	2	2			3	1		2	1	1
4	3	3		3					3	1		2	1	1
5	3	3		3	2				3	1		2	1	1
1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)														

CY22161	CHEMISTRY LABORATORY (Common to all Branches except AD, CS, IT)	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

1.	To acquaint the students with the basic phenomenon/concepts of chemistry, the student face during course of their study in the industry and engineering field.
2.	To appreciate the need and importance of water quality parameters for industrial and domestic use.
3.	To gain the knowledge on electrochemical instrumentation techniques like potential and current measuring used in electrochemistry applications
4.	To impart knowledge on separation of components using paper chromatography.
5.	To enhance the thinking capability about polymer and properties like molecular weight.

LIST OF EXPERIMENTS (Minimum EIGHT experiments)

1.	Determination of DO content of water sample by Winkler's method.
2.	Determination of strength of given hydrochloric acid using pH meter
3.	Determination of strength of acids in a mixture using conductivity meter
4.	Estimation of iron content of the water sample using spectrophotometer (phenanthroline/thiocyanate method)
5.	Determination of total, temporary & permanent hardness of water by EDTA Method.
6.	Estimation of iron content of the given solution using potentiometer.
7.	Determination of alkalinity in water sample.
8.	Determination of Single electrode potential.
9.	Separation of components from a mixture of red and blue inks using Paper chromatography.
10.	Determination of molecular weight of polymer by using Ostwald's/Ubbelohde viscometer.

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Distinguish hard and soft water, solve the related numerical problems on water, purification and its significance in industry and daily life.	**4**
CO2	Interpret the knowledge of instruments to measure potential and current related parameters.	**3**
CO3	Demonstrate the basic principle for separation of components using paper chromatography.	**3**
CO4	Evaluate the molecular weight of polymer using Ostwald's/Ubbelohde viscometer.	**3**

TEXTBOOKS:

1.	Furniss B.S. Hannaford A.J, Smith P.W.G and Tatchel A.R., "Vogel"s Textbook of practical organic chemistry", LBS Singapore 1994.

2.	Jeffery G.H., Bassett J., Mendham J. and Denny Vogel's R.C, "Text book of quantitative analysis chemical analysis", ELBS 5th Edn. Longman, Singapore publishers, Singapore, 1996.

REFERENCES:

1.	Daniel R. Palleros, "Experimental organic chemistry" John Wiley & Sons, Inc., New York 2001.
2.	Kolthoff I.M., Sandell E.B. et al. "Quantitative chemical analysis", Mcmillan, Madras 1980

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2				3	3	3	1		1	2		
2	3	2	1			3	3	3						
3	3					3	3					2		
4	3			1		3	3	3						

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

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS

Sl.No	Item Description	Qty.
1.	Common apparatus: Pipette, Burette, conical flask, porcelain tile, dropper	30 nos each
2.	Iodine flask	30
3.	pH meter	5
4.	Conductivity meter	5
5.	Spectrophotometer	5
6.	Oswald/UbbelohdeViscometer	30

CS22161	PROGRAMMING IN C LABORATORY (Common to ME and MN)	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

1.	Be exposed to the syntax of C.
2.	Be familiar with programming in C.
3.	Learn to use arrays, strings, functions, pointers, structures and unions in C.

LIST OF EXPERIMENTS

1.	Programs using IO functions and Command line arguments – scanf(), printf(), gets(), puts(), Format specifier separated with space/comma, input through terminal
2.	Programs to evaluate the expression using operators in C – Arithmetic, Logical, Relational, Bitwise, conditional and sizeof() operators
3.	Scientific problem solving using decision making and looping – Find largest/smallest among numbers, Even or Odd number, Factorial, Krishnamurthy number, Armstrong number, Prime number or not, Grade of students based on marks, Leap year or Not, Fibonacci series and the sum of Geometric series
4.	Simple programming for one-dimensional and two-dimensional arrays – Searching, Sorting, Replacing and Two-dimensional Matrix Operations
5.	Solving problems using Strings – Palindrome, Cipher a string and Sorting the names
6.	Programming using user-defined functions (Pass by value and Pass by reference) – Swapping numbers, Convert a temperature from F to C, Average of marks by passing n subject marks in an array.
7.	Programming using Recursion – Find factorial, sum of N numbers, sum of $x^{y,}$ Number Conversion using recursion
8.	Programming using Pointers – Swapping three numbers without temporary variable, double pointers
9.	Programming using structures and union
10.	Programming using enumerated data types
11.	Programming using macros - #define, #ifdef, #if, #else and #endif
12.	Programming using Files – Display the content of file and Copy from one file to other

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Use various arithmetic and logic operators in C	**1**
CO2	Implement control statements of C language to solve scientific problems	**2**
CO3	Develop programs using array and string operations to solve problems.	**3**
CO4	Create user-defined functions to perform a task.	**3**
CO5	Develop programs using file operations to store and retrieve data	**3**

REFERENCES:

1.	Pradip Dey, Manas Ghosh, "Programming in C", First Edition, Oxford University Press, 2018
2.	Ashok N Kamthane, "Programming in C", Third Edition, Pearson, 2015

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	1		2	2										
2	2	1	2	2										
3	1		2	1										
4	1	1	2	2										

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl.No	Item Description	Qty.
1.	Standalone desktops with C compiler or Server with C compiler.	30

SEMESTER II

HS22251	அறிவியல் மற்றும் தொழில் நுட்பத்தில் தமிழ் **Science and Technology in Ancient Tamil Society** **(Common to all Branches)**	L	T	P	C
		2	0	0	2

பாடத்தின் நோக்கங்கள்:

1.	அறிவியலில் தமிழின் பயன்பாடு பற்றி தெரிந்து கொள்வார்கள்.
2.	தொழில்நுட்பத்தில் தமிழ் பாரம்பரியத்தின் தாக்கம் பற்றி அறிந்து கொள்வார்கள்.

அலகு 1 அறிவியல் தமிழ் **3**

கருவி உருவாக்கம் - ஆராய்ச்சி மேம்பாடு - கல்வி வளர்ச்சி - அறிவியல் தமிழ் சொற்கள் உருவாக்கம்.

Scientific Tamil : Tool Development - Research Development - Educational Development - Scientific Tamil words Creation.

அலகு 2 தொழில் நுட்பத்தில் தமிழ் **12**

வடிவமைப்பு மற்றும் கட்டுமான தொழில்நுட்பம்: சங்க காலத்தில் கட்டுமானப் பொருட்கள் - சோழர்களின் பெரிய கோவில்கள் மற்றும் பிற வழிபாட்டு தலங்கள் - பல்லவர்களின் சிற்பங்கள் மற்றும் கோவில்கள் (மாமல்லபுரம்) - நாயக்கன் கால கோவில்கள் (மதுரை மீனாட்சி அம்மன் கோவில்), திருமலை நாயக்கர் மஹால், செட்டி நாட்டு வீடுகள்.

Design and Construction Technology : Building materials in Sangam age – Great temples of Cholas and other workship places – Sculptures and Temples of Pallavas (Mamallapuram) – Temples of Nayakas period (Madurai Meenakshi Amman temple), Thirumalai Nayakar Mahal, Chetti Nadu Houses.

உற்பத்தி தொழில்நுட்பம் : கப்பல் கட்டும் கலை, உலோகவியல் ஆய்வுகள், தங்கம், தாமிரம், இரும்பு பற்றிய அறிவு - தொல்பொருள் சான்றுகள் – சுட்டக் களிமண் மணிகள், சங்கு மணிகள், எலும்பு மணிகள்.

Manufacturing Technology : Art of Ship building, Metallurgical studies, Knowledge about Gold, Copper, Iron – Archeological evidences – Terracotta beads, Shell beads, Bone beads.

விவசாயம் மற்றும் நீர்ப்பாசன தொழில்நுட்பம் : அணைகள், ஏரிகள், குளங்கள், மதகுகள், சோழர் கால குமுழி தூம்பு ஆகியவற்றின் முக்கியத்துவம் - கால்நடை பராமரிப்பு, கால்நடைகளின் பயன்பாட்டிற்காக வடிவமைக்கப்பட்ட கிணறுகள். விவசாயம் மற்றும் வேளாண் செயலாக்கம் - கடல் பற்றிய அறிவு - மீன்பிடித்தல், முத்து குளித்தல், சங்கு சேகரித்தல்.

Agriculture and Irrigation Technology: Dams, Tank, ponds, sluice, Significance of Kumuzhi Thoompu of Cholas period- Animal Husbandry, Wells designed for cattle use. Agriculture and Agro processing, - Knowledge about Sea – Fisheries, Pearl, Conche diving.

தமிழ் கணினி: அறிவியல் தமிழ் வளர்ச்சி - தமிழ் கணினி, தமிழ் புத்தகங்களின் டிஜிட்டல் மயமாக்கல், தமிழ் டிஜிட்டல் நூலகம், தமிழ் மென்பொருள் உருவாக்கம் - தமிழ் மெய்நிகர் அகாடமி - சொற்குவை திட்டம்.

Tamil Computing : Development of Scientific Tamil – Tamil Computing, Digitization of Tamil books, Tamil Digital Library, Development of Tamil Softwares – Tamil virtual Academy – Sorkuvai project.

தமிழின் எதிர்காலமும் தகவல் தொழில்நுட்பமும்- உலகமயமாக்கலும் தகவல் தொழில் நுட்பமும் - கணினிக்கு தமிழ் கற்று கொடுத்தல் - தமிழ் மொழித் தொழில் நுட்பத்தில் வளங்கள்.

Future of Tamil and Information Technology- Globalization and Information Technology-Teaching Tamil for Computer-Resources in Tamil Language Technology.

மொத்தம்: 15 காலங்கள்

பா.வெ. எண்	பாடத்திட்டத்தின் வெளிப்பாடு
CO1	அறிவியலில் தமிழ் மொழியின் பயன்பாடு பற்றி தெரிந்து கொள்வார்கள்
CO2	பல்வேறு தொழில்நுட்பத்தில் தமிழ் மொழியின் தாக்கம் பற்றி அறிந்து கொள்வார்கள்

பாட நூல்கள்:

1.	**டாக்டர், வா·செ ·குழந்தைசாமி (1985),** " அறிவியல் தமிழ் " , பாரதி பதிப்பகம், 126/108, உஸ்மான் சாலை, தியாகராய நகர் , சென்னை 600017.
2.	**சுப. திண்ணப்பன், (1995),** "கணினியும் தமிழ் கற்பித்தலும்", புலமை வெளியீடு, 38-B மண்ணத்நதோட்டத் தெரு, ஆழ்வார்பேட், சென்னை 600018.
3.	**மு. பொன்னவைக்கோ, (2003),** "வளர் தமிழில் அறிவியல் – இணையத்தமிழ்", அனைத்திந்திய அறிவியல் தமிழ்க்கழகம், தஞ்சாவூர் 615005
4.	**துரை. மணிகண்டன், (2008),** "இணையமும் தமிழும்", நல் நிலம் பதிப்பகம், 7-3, சிமேட்லி சாலை, தியாகராய நகர், சென்னை 600017.

HS22252	TECHNICAL ENGLISH (Common to all Branches)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	Enable learners to define and understand technical communication and scientific writing
2.	Expose learners to the technicalities of seminar presentation, group discussion, and public speaking
3.	Develop learners' writing skills for scientific and documenting purposes
4.	Improve learners' ability to draft correspondences for business purposes
5.	Cultivate learners' ability to holistically understand the nuances of job interviews and recruiting process

UNIT I **9**

Listening – AV files pertaining to manufacturing processes of products, scientific documentaries; **Speaking**- syllable division and word stress, intonation, sharing opinions; **Reading** – news articles related to science and technology; **Writing** – definitions, instruction, recommendation, data interpretation, resume; **Grammar** – tenses and their aspects, sentence connectors - discourse markers, sequential words, active and passive voice, subject-verb agreement.

UNIT II **9**

Listening – AV pertaining to marketing strategies, peer reading and pronunciation; **Speaking** - turn taking, sharing opinions; conducting and attending a meeting, understanding the nuances of spoken communication among internal audience and external audience,; **Reading** - analytical documents, descriptive documents; **Writing** - fliers, brochures, resume- letter of application, checklists; **Grammar** - modal verbs, clauses – types and uses, conditional clauses, articles.

UNIT III **9**

Listening – AV related to how to use components, scientific description, **Speaking** - speaking for motivation and initiation, speaking at a seminar presentation; **Reading** – scientific journals, papers; **Writing** – Technical descriptions – process description, purpose and function, PowerPoint, Google forms, user manuals; **Grammar** - phrasal verbs, prepositions, technical and scientific affixes

UNIT IV **9**

Listening - scientific debates, crisis management; **Speaking** - handling conflicts, speaking about the loss of benefits, progress or decline of business, identifying the connotative meanings, **Reading**- documented evidences of uses and functions of a product, review of a product, **Writing** – memos, follow-up letters, reports - proposal, project, progress reports, sales reports, reports on industrial visits, executive summary. **Grammar** - reported speech and tag questions, sentence structure – comparative, imperative, cause and effect, infinitive of result.

UNIT V **9**

Listening – AV of Group discussions, panel discussions, face to face interviews for recruitment purposes; **Speaking**- speaking at group discussions, interviewing a personality, answering at the interviews; **Reading** – WebPages of topnotch engineering companies, **Writing** - blogging, e-mails, letter of complaint, minutes of the meeting ; **Grammar** - one word substitution, collocations, better word/sentence substitution (rephrasing the content/improvising ideas).

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES (5 Cos)	RBT Level
At the end of the course, students will be able to:		
CO1	Understand the nuances of technical communication and scientific writing	3
CO2	Present papers and give seminars	6
CO3	Discuss in groups and brainstorm	6
CO4	Draft business correspondences and write for documenting purposes	6
CO5	Face job interviews with confidence	6

REFERENCES:

1.	Orient Blackswan, Chennai. 2012
2.	Downes, Colm, Cambridge English for Job-hunting, Cambridge University Press, New Delhi. 2008
3.	Murphy, Raymond, Intermediate English Grammar with Answers, Cambridge University Press 2000
4.	Thomson, A.J. Practical English Grammar 1& 2 Oxford 1986.
5.	Herbert A J, The Structure of Technical English Longman, 1965

E-RESOURCES:

1.	http://www.usingenglish.com
2.	http://www.uefap.com3
3.	https://owl.english.purdue.edu/owl/
4.	www.learnenglishfeelgood.com/esl-printables-worksheets.html

SOFTWARE:

1.	Face2Face Advance – Cambridge University Press, 2014
2.	English Advance Vocabulary- Cambridge University Press
3.	IELTS test preparation – Cambridge University Press 2017
4.	Official Guide to the TOEFL Test With CD-ROM, 4th Edition
5.	CAMBRIDGE Preparation for the TOEFL TEST- Cambridge University Press, 2017

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1										3				
2										3				
3										3				

4										3				
5										3				
1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)														

MA22251	APPLIED MATHEMATICS - II (Common to all except MR)	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

1.	Acquire the concepts of vector calculus needed for problems in all engineering disciplines and compute different types of integrals using Green's, Stokes' and Divergence theorems.
2.	Skilled at the techniques of solving ordinary differential equations that model engineering problems.
3.	Extend their ability of using Laplace transforms to create a new domain in which it is easier to handle the problem that is being investigated.
4.	Explain geometry of a complex plane and state properties of analytic functions.
5.	Understand the standard techniques of complex variable theory so as to apply them with confidence in application areas such as heat conduction, elasticity, fluid dynamics and flow of electric current.

UNIT I	VECTOR CALCULUS	12

Gradient, divergence and curl - Directional derivative - Vector identities – Irrotational and solenoidal vector fields - Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (excluding proofs) – Verification and application in evaluating line, surface and volume integrals.

UNIT II	ORDINARY DIFFERENTIAL EQUATIONS AND ITS APPLICATIONS	12

Differential equations of first order – Equations of the first order and first degree – Linear equations – Higher order linear differential equations with constant coefficients - Method of variation of parameters - Cauchy's and Legendre's linear equations - Simultaneous first order linear equations with constant coefficients – Applications of Linear differential equations – Oscillatory electrical circuit – Deflection of beams.

UNIT III	LAPLACE TRANSFORM	12

Conditions for existence - Transform of elementary functions - Transforms of unit step function and impulse functions – Basic properties – Shifting theorems - Transforms of derivatives and integrals of functions - Derivatives and integrals of transforms - Initial and final value theorems - Transform of periodic functions. Inverse Laplace transforms - Convolution theorem – Application to solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

UNIT IV	ANALYTIC FUNCTIONS	12

Analytic functions - Necessary and sufficient conditions (Cauchy-Riemann equations) - Properties of analytic function - Harmonic conjugates - Construction of analytic functions - Conformal mapping – Mapping by functions W = Z + C, CZ, 1/Z, Z2 – Joukowski's transformation- Bilinear transformation.

UNIT V	COMPLEX INTEGRATION	12

Cauchy's integral theorem - Cauchy's integral formula - Taylor's and Laurent's series expansions - Singular points - Residues - Cauchy's Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semi-circular contour.

TOTAL: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Interpret the fundamentals of vector calculus and execute evaluation of line, surface and volume integrals using Gauss, Stokes and Green's theorems.	**3**
CO2	Solve first order linear, homogeneous differential equations and use series solution method to solve second order differential equations.	**3**
CO3	Determine the methods to solve differential equations using Laplace transforms and Inverse Laplace transforms.	**3**
CO4	Explain Analytic functions and Categorize transformations.	**3**
CO5	Perform Complex integration to evaluate real definite integrals using Cauchy integral theorem and Cauchy's residue theorem	**3**

TEXTBOOKS:

1.	Erwin Kreyszing, Herbert Kreyszing, Edward Norminton, "Advanced Engineering Mathematics", 10th Edition, John Wiley, (2015).
2.	Grewal .B.S, Grewal .J.S "Higher Engineering Mathematics",43rd Edition, Khanna Publications, Delhi, (2015).

REFERENCES:

1.	Dass, H.K., and Rajnish Verma, "Higher Engineering Mathematics", S.Chand Private Ltd., 2011.
2.	Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, (2013).
3.	Bali N. P and Manish Goyal, "A Text book of Engineering Mathematics", 9th edition, Laxmi Publication (p) Ltd., 2014.

E-RESOURCES:

1.	https://nptel.ac.in/courses/111/105/111105134/
2.	https://nptel.ac.in/courses/111/105/111105121/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3										3		
2	3	3	2									3		
3	3	3	2									3		
4	3	3										3		
5	3	3										3		

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

PH22253	ENGINEERING MATERIALS (Common to AE, ME, MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To impart the knowledge about the properties of engineering and ceramic materials to the students.
2.	To enhance the knowledge about the electron behaviour in the semiconductor and dielectric materials.

UNIT I	PHASE DIAGRAMS AND NON-FERRROUS ALLOYS	8

Solid solutions - Hume Rothery's rules – Phase rule - single component system - one- component system of Iron - binary phase diagrams - Isomorphous systems - Tie-line rule - the Lever rule - application to Isomorphous system - Cu – Ni system - Eutectic phase diagram - Peritectic phase diagram - other invariant reactions - Cu – Zn system - Microstructural change during cooling.

UNIT II	FERROUS ALLOYS AND HEAT TREATMENT	10

Fe-C equilibrium diagram : phases, invariant reactions - microstructure of slowly cooled steels - Eutectoid steel, hypo and hypereutectoid steels - effect of alloying elements on the Fe-C system - Diffusion in solids: Fick's laws - phase transformations - T-T-T-diagram for eutectoid steel - Pearlite, Baintic and Martensitic transformations - tempering of Martensitic - Heat treatment of steels : Annealing - Normalizing - Quenching and Tempering - Case hardening - Induction, Flame and Laser hardening - Carburizing, Cyaniding, Carbonitriding and Nitriding.

UNIT III	SEMICONDUCTING MATERIALS	8

Introduction - classification of materials based on band theory (metals, semiconductors and insulators) - intrinsic and extrinsic semiconductors - carrier concentration in intrinsic semiconductor (derivation) - effect of temperature on Fermi level - compound semiconductors - variation of electrical conductivity in intrinsic semiconductors with temperature - Band gap determination of intrinsic semiconductor (derivation and experiment) - Hall effect (derivation and experiment).

UNIT IV	DIELECTRIC, MAGNETIC AND SUPERCONDUCTING MATERIALS	10

Dielectric materials - Dielectric constant - Polarization of dielectric materials - Types of Polarization (Polarisability) - Equation of internal fields in solid (One- Dimensional) (Derivation) - Claussius-Mosotti Relation for elemental dielectric materials - Dielectric Breakdown - Frequency dependence of dielectric constant, Dielectric Losses - Important applications of dielectric material.

Magnetic Materials: Dia, Para and Ferro magnetic material - Domain theory for Ferro magnetic materials - Phenomena of Hysteresis and its applications - Ferrites and its structures.

Introduction to Superconductivity : Meissner effect - Properties of superconductors - Type I and Type II superconductors - BCS theory (Qualitative) - Low Tc and High Tc (alloy) superconductors - Ceramic superconductors (oxide superconductors) - Applications of Superconductors.

UNIT V	CERAMIC AND NEW MATERIALS	9

Ceramics : types and applications, **Composites:** Ceramic Fibres - Fibre reinforced Plastics - Fibre reinforced Metal - **Metallic glasses**: preparation, Properties and applications.

Shape memory alloys : shape memory effect, phases, pseudo elastic effect, NiTi alloy, Properties and applications.

Nanomaterials: preparation, properties and applications.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Know about the phase diagrams of various alloys	**3**
CO2	Know about the heat treatment of alloys and alloy steels.	**3**
CO3	Understand the behavior of electrons in the semiconductors.	**3**
CO4	Know about the properties and engineering applications of magnetic and dielectric materials.	**3**
CO5	Enhance knowledge about ceramics and smart materials.	**2**

TEXTBOOKS:

1.	Arumugam. M, "Materials Science", Anuradha Publications, 2015.
2.	Rajendran. V, "Engineering Physics", Tata McGraw Hill, 2015.
3.	Suresh. R and Jayakumar. V, "Materials Science", Lakshmi Publications, 2003.
4.	Raghavan. V, "Materials Science and Engineering - A first course", Sixth Edition, PHI publications, 2015

REFERENCES:

1.	Gaur. R.K and Gupta. S.L, "Engineering Physics", Dhanpat Publications, 2015.
2.	Avadhnaulu. M.N and Kshirsagar, "A Text book of Engineering Physics", S. Chand & Co. 2006.
3.	Kittlel. C, "Introduction to Solid State Physics", 7th Edition, Wiley Eastern Ltd., 2004.
4.	Azaroff. L.V and Brophy. J.J, "Electronic Processes in Materials", McGraw Hill., 1963.

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2	2							1		2		
2	3	2	2	2	2	2			2	1		2		
3	3					2				1		2		
4	3		2			2				1		2		
5	3	2	2	2	2	2			2	1		2		

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

ME22201	ENGINEERING MECHANICS (Common to ME, MN, MR)	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES:

1.	To understand the concept of equilibrium of particles.
2.	To understand the concept of equilibrium of rigid bodies.
3.	To understand the concept of first and second moment of area.
4.	To understand the concept of various types of frictions and applications.
5.	To understand the principle of work energy method, Newton's law and impact of elastic bodies.

UNIT I BASICS AND STATICS OF PARTICLES **9**

Introduction - Units and Dimensions - Laws of Mechanics - Principle of transmissibility - Parallelogram and triangular Law of forces - Vectorial representation of forces - Vector operations of forces - additions, subtraction, dot product, cross product - Coplanar Forces - rectangular components - Equilibrium of a particle - Lami's theorem - Forces in space - Equilibrium of a particle in space - Equivalent systems of forces.

UNIT II STATICS OF RIGID BODIES AND ANALYSIS OF STRUCTURES **9**

STATICS OF RIGID BODIES: External, Internal forces - moment of a force - Varignon's theorem - moment of a couple - resolution of a force into a force and a couple - reduction of a system of forces - reactions at supports and connections - equilibrium of a two and three force bodies - case studies.

ANALYSIS OF STRUCTURES: Simple trusses - Method of joints, method of sections - joints under special loading conditions - space trusses - analysis of frames.

UNIT III CENTROID, CENTRE OF GRAVITY AND MOMENT OF INERTIA **9**

Centroid of areas, composite areas, Centre of Gravity- Theorems of Pappus and Guldinus- Parallel axis theorem and perpendicular axis theorem - determination of moment of inertia of plane figures, polar moment of inertia-radius of gyration - mass moment of inertia of simple solids.

UNIT IV FRICTION **9**

Laws of dry friction - angles of friction-coefficient of static and kinetic friction - wedges - surface contact friction - belt friction - journal bearings - axle friction - thrust bearings - disc friction - Point contact friction - wheel friction - rolling resistance - case studies.

UNIT V DYNAMICS OF PARTICLES **9**

KINEMATICS: Introduction-plane, rectilinear and rotary motion-time dependent motion - rectangular coordinates - projectile motion.

KINETICS: Newton's II law - D'Alembert's principle - Energy - potential energy - kinetic energy - conservation of energy - work done by a force - work energy method.

IMPULSE AND MOMENTUM: Concept of conservation of momentum - Impulse-Momentum principle - Impact - Direct central impact, oblique central impact, impact of a moving train on the springboard.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand and analyze the various methods to determine the resultant forces and its equilibrium acting on a particle in 2D and 3D.	2
CO2	Understand and analyze the concept of reaction forces and moment of various support systems with rigid bodies in 2D and 3D in equilibrium.	2
CO3	Evaluate centroid, Area moment of Inertia and Mass moment of Inertia of cross section of any structural member.	3
CO4	Correlate the engineering problems dealing with force, displacement, velocity and acceleration equations	3
CO5	Evaluate the problems in friction and rigid body dynamics	3

TEXTBOOKS:

1.	Beer Ferdinand P, Russel Johnston Jr., David F Mazurek, Philip J Cornwell, Sanjeev Sanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Higher Education., 11th Edition, 2017.
2.	Vela Murali, "Engineering Mechanics-Statics and Dynamics", Oxford University Press, 2018.
3.	Rajasekaran S and Sankarasubramanian G, "Engineering Mechanics Statics and Dynamics", 3rd edition, Vikas Publishing House Pvt. Ltd., 2005.

REFERENCES:

1.	Boresi P and Schmidt J, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.
2.	Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
3.	Irving H. Shames, Krishna Mohana Rao G, Engineering Mechanics – Statics and Dynamics, 4thEdition, Pearson Education Asia Pvt. Ltd., 2005.
4.	Meriam J L and Kraige L G, Engineering Mechanics: Statics and Engineering Mechanics: Dynamics, 7th edition, Wiley student edition, 2013.
5.	Timoshenko S, Young D H, Rao J V and Sukumar Pati, Engineering Mechanics, 5th Edition, McGraw Hill Higher Education, 2013.

E-RESOURCES:

1.	https://nptel.ac.in/courses/112103108

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2	2	1	2								2	
2	3	2	2	1	2								2	
3	3	2	3	1	3								2	
4	3	2	3	1	3								2	
5	3	2	3	1	3								2	

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

EE22151	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING (Common to all Branches except CH, EE, EC)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To understand the basic theorems used in Electrical circuits.
2.	To educate on the different concepts and functions of electrical machines.
3.	To introduce electron devices and its applications.
4.	To explain the principles of digital electronics.
5.	To impart knowledge on the principles of measuring instruments.

UNIT I	ELECTRICAL CIRCUITS	9

Ohm's Law – Kirchhoff's Laws - Steady State Solution of DC Circuits using Mesh and Nodal Analysis -Introduction to AC Circuits - Waveforms and RMS Value - Power and Power factor - Single Phase and Three Phase AC Balanced Circuits.

UNIT II	ELECTRICAL MACHINES	9

Construction, Principle of Operation, Basic Equations and Applications of DC Generators, DC Motors, Single phase induction Motor, Single Phase Transformer.

UNIT III	SEMICONDUCTOR DEVICES AND APPLICATIONS	9

Characteristics of PN Junction Diode - Zener Effect - Zener Diode - LED, Photo diode and its Characteristics-Half Wave and Full Wave Rectifiers-Voltage Regulation. Bipolar Junction Transistor- Common Emitter Configuration, Characteristics and CE as an Amplifier - Photo transistors.

UNIT IV	DIGITAL ELECTRONICS	9

Number System Conversion Methods–Simplification of Boolean Expression using K-Map – Half and Full Adders – Flip-Flops – Shift Registers - SISO, SIPO, PISO, PIPO and 4-bit Synchronous and Asynchronous UP Counters.

UNIT V	MEASURING INSTRUMENTS	9

Types of Signals: Analog and Digital Signals- Construction and working Principle of Moving Coil and Moving Iron Instruments (Ammeters and Voltmeters), Dynamometer type Watt meters and Energy meters. Instrumentation Amplifier, – R-2R ladder Type D/A Converter - Flash Type and Successive Approximation Type A/D Converter.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Compute the electric circuit parameters for simple problems	4
CO2	Understand the construction and characteristics of different electrical machines	4
CO3	Describe the fundamental behavior of different semiconductor devices and circuits.	4
CO4	Design basic digital circuits using Logic Gates and Flip-Flops	4
CO5	Analyze the operating principle and working of measuring instruments	4

TEXTBOOKS:

1.	Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", Second Edition,

	McGraw Hill Education, 2020.
2.	SedhaR.S., "A Text Book of Applied Electronics", S.Chand & Co., 2014
REFERENCES:	
1.	Muthusubramanian R, Salivahanan S and Muraleedharan K A, "Basic Electrical, Electronics Engineering", Tata McGraw Hill, 2013.
2.	MehtaVK,"Principles of Electronics", S. Chand &CompanyLtd, 2010.
3.	M. Morris Mano, "Digital Logic & Computer Engineering", Prentice Hall of India, 2004.
4.	Mahmood Nahvi and Joseph A.Edminister,"Electric Circuits", Schaum' Outline Series, McGraw Hill, Fourth Edition, 2007.

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3			2					2		
2	3	3	3	3			2					2		
3	3	3	3	3			2					2		
4	3	3	3	3			2					2		
5	3	3	3	3			2					2		

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

ME22211	PRODUCTION DRAWING LABORATORY (Common to ME and MN)	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

1.	To introduce the concept of 2D drafting using CAD packages.
2.	To improve communications through documentation, and to promote awareness for manufacturing.
3.	To introduce students to understand standards of drawing in mechanical engineering
4.	To acquire knowledge in Coordinate Measuring machine (CMM) for geometric features

LIST OF EXPERIMENTS

1.	**INTRODUCTION TO COMPUTER AIDED DRAFTING** Introduction to Computer Aided Drafting hardware – Overview of application software – 2D drafting commands like Layers, Block, Insert (Auto CAD) for simple objects – Dimensioning.
2.	**EXPERIENTIAL LEARNING ON LIMITS, FITS AND TOLERANCE THROUGH MACHINE ELEMENTS** Basics of Limits, fits, and Tolerance – Identification of types of fits by simple assembly of machine components – Selection of fits from standard tables – types of fits – Demonstration
3.	**GEOMETRIC DIMENSIONING** Basics of Geometric Dimensioning and Tolerance – Measuring of Machine components using CMM – Experiment on cylindricity, circularity, parallelism and perpendicularity.
4.	**PRACTICE ON ASSEMBLY DRAWINGS** Cotter joint, knuckle joint, flange coupling, universal coupling, footstep bearing, Plummer block, connecting rod ends, screw jack (any four)

NOTE:

1. Expose to CMM for the measurement of Geometric dimensioning is Mandatory
2. Any two assembly drawing should be practiced manually by the student.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	The students will be able to read and interpret the production drawings	3
CO2	The students will be able to understand proper fits and tolerances.	5
CO3	The students will generate assembly drawings for various mechanical products	5
CO4	The students will acquire skill to measure the machine components geometry using CMM	4

REFERENCES:

1.	Gopalakrishna K.R., “Machine Drawing”, Subhas Publishers, Bangalore, 2013.
2.	Gill P.S,”Machine Drawing”, S.K. Kataria & Sons Publications, 2013
3.	Bhatt.N.D, “Machine Drawing”, Chorotar Publishing House, 2011.

4.	Sham Tickoo, "AutoCAD 2017: A Problem-Solving Approach, Basic and Intermediate", 23rd Edition, 2017
5.	James D. Bethune Boston University, "Engineering Graphics with AutoCAD 2002", Pearson Education, 2005.
6.	Alan Kalameja, "AutoCAD 2008: A tutor for Engineering Graphics", Auto Desk Press 2007
7.	https://thesourcecad.com/autocad-tutorials/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3				3					2		3	2	
2	3				3					2		3	2	
3	3		1		3					2		3	2	
4	3				3				1			3	2	
5	3				3					2		3	2	

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

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS

Sl. No	Item Description	Qty.
HARDWARE		
1.	Computer Server	1
2.	Computer nodes or systems (High end CPU with atleast 1 GB main memory) networked to the server	30
3.	A3 size plotter	1
4.	Laser Printer	1
SOFTWARE		
5.	Licensed software for Drafting and Modeling	30 licenses
6.	Licensed operating system	Adequate

EE22111	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY (Common to all branches except EC)	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

1.	To provide exposure to the students with hands on experience in basic of Electrical and Electronics wiring connection and measurements.
2.	To introduce the students to Electrical Machines and basic laws of Electrical Circuits.

LIST OF EXPERIMENTS

1.	Wiring – Residential house wiring and Stair case wiring.
2.	(a) AC Analysis- Measurement of electrical quantities–voltage, current, power, and power factor using RLC. (b) Study of three phase system.
3.	Energy conservation - Measurement and comparison of energy for incandescent lamp and LED lamp.
4.	(a) Identification of circuit components (Resistor, Capacitor, Diode and BJT) and soldering practice. (b) Signal Measurement- Measurement of peak to peak, RMS, average, period, frequency of signals using CRO.
5.	(a) VI Characteristics of Solar photovoltaic panel. (b) Design of Solar PV Array and Battery sizing for Residential solar PV system.
6.	Design a 5V/12V Regulated Power Supply using FWR and IC7805 / IC7812.
7.	DC Analysis- Verification of Ohm's Law and Kirchhoff's Laws.
8.	Study of Transformer and motor characteristics.

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Wiring of basic electrical system and measurement of electrical parameters.	4
CO2	Verify the basic laws of Electric circuits and select various Electrical Machines.	4
CO3	Construct electronic circuits and design solar photovoltaic system.	4
CO4	Apply the concept of three-phase system.	4
CO5	Construct a fixed voltage regulated power supply.	4

REFERENCES:

1.	Mittle V.N, Arvind Mittal, "Basic Electrical Engineering", Tata Mc Graw Hill (India), Second Edition, 2013.
2.	Sedha R.S., "A Textbook of Applied Electronics", S. Chand & Co., 2014.

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	3	3					2			2		

2	3	3	3	3					2			2		
3	3	3	3	3					2			2		
4	3	3	3	3					2			2		
5	3	3	3	3					2			2		
1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)														

SEMESTER III

MA22355	PARTIAL DIFFERENTIAL EQUATIONS AND NUMERICAL METHODS (Common to AE, BT, MN)	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

1.	Skilled at the techniques of solving partial differential equations.
2.	Understand the application of partial differential equations in heat transfer problems.
3.	Learn the solution of algebraic, transcendental equations, system of linear equations.
4.	Understand the concept of interpolation and approximation.
5.	Understand how to solve initial and boundary value problems in differential equations.

UNIT I	PARTIAL DIFFERENTIAL EQUATIONS	12

Formation of partial differential equations - Singular integrals - Solutions of standard types of first order partial differential equations - Lagrange's linear equation - Linear homogeneous partial differential equations of second and higher order with constant coefficients.

UNIT II	APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS	12

Classification of partial differential equations – Fourier series – Half range Fourier sine and cosine series - Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction in Cartesian form (excluding insulated edges) – Steady state solution two dimensional heat equation in polar form (circular, semicircular and quadrant plate).

UNIT III	SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS	12

Solution of algebraic and transcendental equations: Newton Raphson method - Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Gauss Seidel Iterative methods - Matrix Inversion by Gauss Jordan method - Eigen values of a matrix by Power method.

UNIT IV	INTERPOLATION AND APPROXIMATION	12

Interpolation with unequal intervals - Lagrange's interpolation – Method-Newton's divided difference interpolation – Finite difference operators and its relations - Interpolation with equal intervals - Newton's forward and backward difference formulae.

UNIT V	INITIAL AND BOUNDARY VALUE PROBLEMS IN DIFFERENTIAL EQUATIONS	12

Finite difference solution of ordinary differential equations - Finite difference techniques for the solution of two-dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method.

TOTAL: 60 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Express** proficiency in handling higher order partial differential equations	3
CO2	**Develop** skills in classification, formulation, solution, and interpretation of partial differential equations model	4

CO3	**Have** the fundamental knowledge of solving an algebraic or transcendental equation, linear system of equations	3
CO4	**Appreciate** the numerical techniques of interpolation in various intervals	3
CO5	**Solve** boundary value problems using finite difference method	3

TEXTBOOKS:

1.	Grewal .B.S, Grewal .J.S "Higher Engineering Mathematics", 43rd Edition, Khanna Publications, New Delhi, 2015.
2.	Kandasamy. P, Thilagavathy. K and Gunavathy. K., "Engineering Mathematics Volume III", 4th Edition, S. Chand & Company ltd, New Delhi, 2008.
3.	Grewal. B.S. and Grewal. J.S., Numerical methods in Engineering and Science, Khanna Publishers, 11th Edition, New Delhi, 2017.

REFERENCES:

1.	Erwin Kreyszing, Herbert Kreyszing, Edward Norminton, "Advanced Engineering Mathematics", 10th Edition, John Wiley, 2015.
2.	Bali N. P and Manish Goyal, "A Text book of Engineering Mathematics", 9th edition, Laxmi Publications (P) Ltd., 2014.
3.	Sankara Rao. K., Numerical methods for Scientists and Engineers, Prentice Hall of India Private, 3rd Edition, New Delhi, 2007.
4.	Venkataraman. M.K. Numerical Methods in Science and Engineering, National Publishers, 2001.

E-RESOURCES: (including NPTEL course)

1.	https://nptel.ac.in/courses/111107111
2.	https://nptel.ac.in/courses/111/107/111107105/
3.	https://nptel.ac.in/courses/111/107/111107063/

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2	2										
2	3	3	2	2										
3	3	3	2	2										
4	3	3	2	2										
5	3	3	2	2										

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

MN22301	INTRODUCTION TO INDUSTRIAL AUTOMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To emphasize the need and role of automation in industries
2. To impart knowledge on different types of devices used in automation
3. To gain awareness on the concepts and applications of automation

UNIT I ELEMENTS OF AUTOMATION **10**

Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Automation in Production System, Production Economics, Costs in Manufacturing, Break Even Analysis, Unit cost of production, Cost of Manufacturing Lead time and Work-in-process.

UNIT II SENSORS AND TRANSDUCERS **9**

Sensors – Classification, Static and Dynamic characteristics, Types – Proximity, Inductive, Capacitive, Optical, Displacement, Temperature, Infrared, Ultrasonic, RFID. Optical encoder & Magneto strictive sensor. Potentiometer, Vibrometer and accelerometer.

Transducers – LVDT, Strain Gauge, Piezoelectric, Diaphragm, Capsule and Bellows Pressure transducers

UNIT III MICROCONTROLLER AND EMBEDDED SYSTEM **9**

Introduction to Microprocessors and Microcontrollers. Architecture of 8085, 8051 and PIC Micro Controllers. Addressing modes, Instruction set Timing diagram. Applications in automation systems.

UNIT IV LEVELS OF AUTOMATION AND MATERIAL HANDLING TECHNIQUES **9**

Levels of Automations, Automated Flow lines, Methods of Work part Transport, Transfer Mechanism, Buffer Storage, Control Functions, and Automation for Machining Operations.

Material handling systems – Conveyors, Automated Guided Vehicle, Automatic tool and pallet changer, Overhead Hoist,

UNIT V APPLICATION AND INTEGRATION **8**

Design and Fabrication Considerations. Automated Flow Lines - Concepts, Partial Automation, and Simulation.

Interfacing Handling and Storage with Manufacturing. Product identification system: Barcode, RFID and QR code.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
	At the end of the course, the students will be able to:	
CO1	**Appraise** the role of various elements available in automation process	2
CO2	**Describe** the working of sensors and transducers used in automation	2
CO3	**Explain** the architecture of various microcontrollers and embedded systems used in automation	2
CO4	**Categorize** the different levels of automation and material handling systems	2
CO5	**Describe** the integration of various elements of automation in real time applications	2

TEXTBOOKS:

1. Ankaj Gupta, “Fundamentals of Microprocessors and Embedded Systems”S.K. Kataria& Sons, 2013
2. Mikell P.Groover, “Automation, Production Systems, and Computer-integrated Manufacturing” Fourth edition, Pearson 2016

REFERENCES:	
1.	Beno Benhabib, “Manufacturing: Design, Production, Automation, and Integration”, CRC Press, First edition, 2003
2.	R.Thomas Wright, “Manufacturing and Automation Technology”,Goodheart-Wilcox Publisher, 2004
3.	Roger W Bolz, “Manufacturing Automation Management: A Productivity Handbook”, Springer Publications, 2011
4.	B.K. Ghosh, Ning Xi and T.J.Tarn, “Control in Robotics and Automation: Sensor Based Integration, Academic Press Inc. 2000

E-RESOURCES:	
1.	https://nptel.ac.in/courses/108108147
2.	https://nptel.ac.in/courses/106105193
3.	https://nptel.ac.in/courses/108105088

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2										1	1	2
2	3	1										1	1	2
3	3	1	1									1	1	2
4	3	2	1	1								1	1	2
5	3	3	3	2	1							1	1	3

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

ME22302	MECHANICS OF MATERIALS (Common to ME and MN)	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES:

1.	To understand the relationship between the forces, internal stresses and the deformations induced in the non-rigid bodies.
2.	To familiarize the student in calculating shear force, bending moment, deflection, and slopes in various types of beams for different loading conditions.
3.	To solve industrial problems related to springs and shafts.
4.	To understand the concepts of thin cylinder and applications related to biaxial stresses.

UNIT I	STRESS AND STRAIN	9

Definition of stress and strain, tension, compression, shear stress and strain – Stress and strain relationship, Hooke's law, Poisson's ratio, Elastic constants and their relations, thermal stresses. Composite bars for static load condition.

UNIT II	MEMBERS SUBJECTED TO FLEXURAL LOADS	9

Types - Transverse Loading in Beams - Shear Force and Bending Moment in Beams – Cantilevers - Simply Supported and Overhanging Beams - Point of contraflexure. Stresses in Beams: Theory of Simple Bending – Analysis of Stress due to bending - Load carrying capacity of Beams.

UNIT III	DEFLECTION OF BEAMS AND COLUMNS	9

Governing differential equation – Double Integration Method - Macaulay's method – Computation of slopes and deflections in beams. Columns: End Condition – Equivalent Length of Column – Euler's Equation – Slenderness Ratio –Rankine's Formula for Columns.

UNIT IV	TORSION OF SHAFTS AND SPRINGS	9

Torsion - formulation of stresses, deformation in circular and hollow shafts, Stepped shafts. Deflection in shafts for different end conditions - Stresses in helical springs - Deflection of helical springs subjected to tension, and leaf springs.

UNIT V	ANALYSIS OF STATE OF STRESS	9

Biaxial State of Stress – Thin Cylinders– Deformation in Thin Cylinders. Biaxial Stresses: Stresses at a Point on Inclined Planes – Principal Planes and Stresses – Mohr's Circle for Biaxial Stress- Maximum Shear Stress.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Predict** the behavior of the materials for different loading and support conditions	3
CO2	**Select** suitable cross sections for the beams under different loading conditions	4
CO3	**Identify** the methodology to find the deflections occurred in beams under different loading conditions	3
CO4	**Select** suitable dimensional parameters for the shafts under torsional loads and springs based on calculated stresses, deflection under different conditions	4
CO5	**Calculate** safe dimension for a Pressure vessel based on the parameters and conditions	4

TEXTBOOKS:

1.	Bansal, R.K., "A Textbook of Strength of Materials", Laxmi Publications (P) Ltd., 2018
2.	Jindal U.C., "Strength of Materials", Asian Books Pvt. Ltd., New Delhi, 2009.

REFERENCES:

1.	Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2017
2.	Ferdinand P. Beer, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", McGraw Hill Education,8th edition, 2019
3.	Rattan, “Strength of Materials”, McGraw Hill Education, 3rd Edition, 2017
4.	Egor. P.Popov “Engineering Mechanics of Solids” Pearson, 2010

E-RESOURCES:

1.	https://nptel.ac.in/courses/112107146
2.	https://nptel.ac.in/courses/112106141
3.	https://archive.nptel.ac.in/courses/105/105/105105108/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3		1	1								3	
2	3	3		2	2								3	
3	3	3											3	
4	3	3		2									3	
5	3	3											3	

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

MN22302	THEORY OF MACHINES	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

1.	To understand formation of mechanisms and their kinematics.
2.	To understand the fundamentals of gears and gear trains.
3.	To analyze the forces acting on simple mechanical systems.
4.	To perform balancing of masses.
5.	To understand the fundamentals of vibrations.

UNIT I	KINEMATICS OF MECHANISMS	14

Mechanisms – Kinematics concepts and definitions – Degree of freedom – Kutzbach criterion, Gruebler‟s criterion – Grashof‟s Law, Kinematic inversions of Four-bar chain and Slider crank chains – Analysis of simple mechanisms - Graphical method using relative velocity.

UNIT II	GEARS AND GEAR TRAINS	12

Spur gear - Law of toothed gearing - Involute gearing - Interchangeability - Gear tooth action interference and undercutting. Gear trains - Epicyclic gear trains and their applications– Introduction to parallel axis gears trains and differential gear trains.

UNIT III	DYNAMIC FORCE ANALYSIS	12

Dynamic force analysis – Inertia force and Inertia torque– D'Alembert's principle – Dynamic force analysis in I.C. Engines. Flywheel- Applications in punching and riveting machines.

UNIT IV	BALANCING OF MASSES AND GYROSCOPIC MOTION	10

Balancing of rotating masses under single and several planes–Introduction to balancing of reciprocating masses. Principles of gyroscopic motion- Determination of gyroscopic couple- Ships and Airplane.

UNIT V	VIBRATIONS	12

Degrees of freedom – Single degree of freedom, Free vibration –Natural frequency – Damped vibration - Types of Damping–vibration isolation materials – Critical speeds of shaft. Introduction to Forced Vibrations.

TOTAL: 60 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, Students will be able to:		
CO1	**Analyze** the kinematics of given mechanism by relative velocity method	4
CO2	**Calculate** the characteristics parameters of various gears and performance of epicyclic gear trains.	3
CO3	**Evaluate** the dynamic forces acting on the elements of slider crank mechanisms.	3
CO4	**Analyze** and solve the unbalancing forces in masses rotating in different planes.	4
CO5	**Calculate** the natural frequency of vibrating bodies under various vibratory motions.	3

TEXTBOOKS:	
1.	Rattan S.S., “Theory of Machines”, Tata McGraw-Hill, New Delhi, 2017.
2.	Shigley J.E., Pennock G.R and Uicker J.J., “Theory of Machines and Mechanisms”, Oxford University Press, 2015.
REFERENCES:	
1.	Rao J.S. and Dukkipati, “Mechanism and Machine Theory”, Wiley- Eastern Ltd., New Delhi, 2015.
2.	John Joseph Uicker, Gordon Pennock, Joseph E. Shigley, “Theory of Machines and Mechanisms”, 5th Edition, Oxford University Press, 2017.
3.	Robert L. Norton, “Kinematics and Dynamics of Machinery”, Tata McGraw-Hill, 2017.
4.	Sadhu Singh, “Theory of Machines: Kinematics & Dynamics”, Pearson Education India, 3rd Edition, 2016.
5.	Ghosh A. and Mallick A.K., “Theory of Mechanisms and Machines”, Affiliated East West Pvt. Ltd, New Delhi, 2008.
E-RESOURCES:	
1.	https://nptel.ac.in/courses/112104121
2.	https://nptel.ac.in/courses/112106270
3.	https://nptel.ac.in/courses/112104114

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3									3			3	
2	3	2								2			3	
3	3	2								2			3	
4	3									3			3	
5	3	2								2			3	

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

MN22303	MANUFACTURING TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To make the students understand fundamentals of casting and special casting processes.
2.	To impart fundamentals of gas welding, arc welding and advanced welding processes.
3.	To impart knowledge on bulk, sheet metal forming and Powder metallurgy.
4.	To teach the students about the various operations that can be performed in various machine tools.
5.	To make the students to realize the importance of nontraditional machining processes in present manufacturing scenario.

UNIT I	METAL CASTING PROCESSES	9

Sand Casting – Green Sand Mould – Type of patterns - Pattern Materials – Pattern allowances – Moulding sand Properties and testing – Cores –Types and applications – Principle of special casting processes- Shell, investment – Pressure die casting – Centrifugal Casting – Continuous casting - Stir casting – Basic defects in Sand casting.

UNIT II	METAL JOINING PROCESSES	9

Fusion welding processes – Type of Gas welding – Flame characteristics – Arc welding, Electrodes, Polarities – Shielded Metal arc welding -Gas metal arc welding – Submerged arc welding – Electro slag welding – Gas Tungsten arc welding – Principle and application of special welding processes – Plasma arc welding – Thermit Welding – Friction welding – Friction stir welding - Resistance welding principle – spot and seam welding – Brazing and soldering.

UNIT III	METAL FORMING PROCESSES AND POWDER METALLURGY	10

Bulk Deformation Processes- Hot working and cold working of metals – Forging processes –Typical forging operations – Rolling of metals – Types of Rolling – Flat strip rolling – shape rolling operations – Principle of rod and wire drawing – Tube drawing – Principles of Extrusion

Sheet Metal Deformation Processes - Typical shearing, bending and drawing operations – Stretch forming operations – Metal spinning – Introduction of Explosive forming, magnetic pulse forming, Super plastic forming – Incremental forming.

Powder metallurgy – Principal steps involved advantages, disadvantages and limitations of powder metallurgy.

UNIT IV	METAL MACHINING PROCESSES	10

Classification of machining processes and machine tools. Tool's materials, different types of cutting tools, tool geometry and nomenclature of single point cutting tool, tool life MRR, Concept of cutting speed, feed and depth of cut.

General principles (with schematic diagrams only) of working and commonly performed operations in the following machines: Lathe, Shaper, Planer, Horizontal milling machine, drilling machine, Cylindrical grinding machine, Capstan and Turret lathe.

UNIT V	NON TRADITIONAL MACHINING PROCESSES	7

General principles and applications of the following processes: Abrasive jet machining, Ultrasonic machining, Electric discharge machining, Electro chemical machining, Plasma arc machining, Electron beam machining and Laser beam machining.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Classify** the different types of casting process and **select** a suitable casting process for a given application	3
CO2	**Categorize** welding processes according to welding principle and will **apply** a suitable welding process for a suitable material	3
CO3	**Select** a suitable deformation and powder metallurgy processes for a given application	3
CO4	**Analyze** the tool life, MRR during machining and will **develop** a process planning sheet for a given component	3
CO5	**Select** a proper Non Traditional Machining method for a given component	3

TEXTBOOKS:

1.	P. C. Sharma, "A Textbook of Production Technology", S.Chand Publications, 2022
2.	R. K. Rajput, " A Textbook of Manufacturing Technology", Laxmi Publications, 2023

REFERENCES:

1.	Mikell P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", Wiley Publications, 7th Edition, 2019.
2.	Serope Kalpakjian & Steven Schmid, "Manufacturing Engineering & Technology", Pearson education, 2022.
3.	J. T. Black, Ronald A. Kohser, "De Garmo's Materials and Processes in Manufacturing", 13th Edition, 2019.

E-RESOURCES:

1.	https://archive.nptel.ac.in/courses/112/107/112107219/
2.	https://nptel.ac.in/courses/112105127
3.	https://archive.nptel.ac.in/courses/112/105/112105126/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2	1			2								
2	3	2	1			2								
3	3	2	1			2								
4	3	2	1			2								
5	3	2	1			2								

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

EE22359	ELECTRICAL DRIVES AND CONTROLS: THEORY AND PRACTICES (Common to ME and MN)	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

1.	To understand the basic concepts of electrical machines and their performance.
2.	To obtain an overview of different dc and ac motors and special electrical machines.
3.	To apply various speed control techniques for DC motor drives, AC motor drives

UNIT I	INTRODUCTION	12

Basic Elements – Types of Electric Drives – factors influencing the choice of electrical drives – heating and cooling curves – classes of duty – Preventive maintenance of electrical drive systems.

UNIT II	DRIVE MOTOR CHARACTERISTICS & SPECIAL MACHINES	12

DC motors: principle, classification, characteristics, merits & demerits, applications–AC motors: principle, classification, characteristics, merits & demerits, applications.

Experiments:

1. Load test on DC Shunt & DC Series motor.
2. Load test on 1Ø & 3Ø squirrel cage Induction Motor.

UNIT III	CONVENTIONAL AND SOLIDSTATESPEEDCONTROL OF DC AND AC DRIVES	12

Principle, classification, construction, and characteristics of stepper motor, Switched reluctance motor, BLDC motor, Servo motor.

Experiments:

1. Characteristics of DC and AC servo motors.

UNIT IV	DC MOTOR CHARACTERISTICS	12

Speed control of DC series and shunt motors – Armature and field control, Ward Leonard control system - Using controlled rectifiers and DC choppers.

Experiments:

1. AC to DC half & fully controlled converter.
2. Speed control of DC shunt motor (Armature, Field control).

UNIT V	AC MOTOR CHARACTERISTICS	12

Speed control of three phase induction motor–Inverter fed induction motor drive – Slip power recovery scheme.

Experiments:

1. Speed control of three phase slip ring Induction Motor.
2. V/F control of three-phase induction motor using Power Electronic Drive.

TOTAL: 60 PERIODS

LABORATORY COMPONENT

OBJECTIVES:

1. To validate the principles studied in theory by performing experiments in the laboratory.

LIST OF EXPERIMENTS

1.	Load test on DC Shunt & DC Series motor
2.	AC to DC half & fully controlled converter.
3.	Speed control of DC motor using Power Electronic Drive

4.	Characteristics of DC and AC servo motors
5.	Load test on three phase squirrel cage Induction motor.
6.	Speed control of three phase slip ring Induction Motor
7.	Load test on single phase Induction Motor.
8.	V/F control of three-phase induction motor using Power Electronic Drive.
9.	AC to DC half & fully controlled converter.

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	**Describe** the structure of electric drive systems and their role in various applications.	3
CO2	**Select** DC and AC motor for practical applications based on its characteristics.	3
CO3	**Understand** the operation of converters, choppers, inverters and ac voltage controllers for DC and AC drives.	3
CO4	**Perform** speed characteristics of different electrical machine.	3
CO5	**Analyze** the performance of AC, DC motor using power electronic drive.	3

TEXTBOOKS:

1.	Gopal K.Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, 2001
2.	Vedam Subrahmaniam, "Electric Drives (concepts and applications)", Tata McGraw-Hill, 2017.
3.	Nagrath .I.J. & Kothari .D.P, "Electrical Machines", Tata McGraw-Hill, 1998.

REFERENCES:

1.	Pillai.S.K, "A first course on Electric drives", Wiley Eastern Limited, 1998
2.	Singh.M.D. K.B.Khanchandani, "Power Electronics", Tata McGraw-Hill, 19983.
3.	Partab. H., "Art and Science and Utilisation of Electrical Energy", Dhanpat Rai and Sons, 1994.
4.	Philip Kiameh "Electrical Equipment Handbook: Troubleshooting & Maintenance", McGraw-Hill, 2003.

E-RESOURCES

1.	https://archive.nptel.ac.in/courses/108/104/108104140/
2.	https://nptel.ac.in/courses/108108077
3.	https://nptel.ac.in/courses/108104011

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	1	1	2		1						2	2	1
2	3	1	1	2								2	2	1
3	3	1	1	2								2	2	1
4	3	1	1	2					2			2	2	1
5	3	1	1	2					2			2	2	1

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS		
Sl. No.	**Description of Equipment**	**Qty**
1.	DC Shunt Motor with loading arrangement	3
2.	DC Series Motor with loading arrangement	1
3.	Three Phase cage Induction Motor with loading arrangement	4
4.	Three phase slip ring Induction Motor with loading arrangement	2
5.	Single Phase Induction Motor with loading arrangement	2
6.	Single phase SCR based half controlled converter and fully controlled converter along with built-in/separate/firing circuit/module and meter	2
7.	AC drive for speed control of Induction Motor	1

ME22313	MANUFACTURING TECHNOLOGY LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

1.	To impart the practical knowledge in casting and joining Processes
2.	To impart the basic machining skills in lathe and to equip with the practical knowledge required in the core industries
3.	To impart machining skills in gear manufacturing and grinding process.

LIST OF EXPERIMENTS

CASTING	
1.	Preparation of green sand mould for single piece pattern
2.	Preparation of green sand mould for split patterns
WELDING	
3.	Butt joint using arc welding
4.	Lap joint using arc welding
5.	Tee joint using arc welding
6.	Corner joint using arc welding
LATHE, GRINDING AND SHAPING MACHINE TOOLS	
7.	Plain turning, Facing, Step turning
8.	Grooving, Knurling, Taper turning
9.	External thread cutting (Single start)
10.	Spur gear cutting using Universal Milling Machine
11.	Cylindrical grinding
12.	Gear Generation – Hobbing and Shaper

TOTAL : 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Make** a green sand mould using different patterns.	3
CO2	**Select** the suitable welding parameters to make weld joints using arc welding.	3
CO3	**Identify** and **perform** the operations in a lathe machine.	3
CO4	**Perform** gear generation operation in gear shaper.	3
CO5	**Perform** grinding operation on the given cylindrical workpiece to achieve required surface finish.	3

REFERENCES:

1.	Serope Kalpak Jian& Steven R. Schmid, “Manufacturing Engineering and Technology”, Pearson India Education Services Pvt. Ltd, 7th edition, 2018
2.	HMT, Production technology, Mc-Graw Hill, 2017
3.	P N Rao, “Manufacturing Technology: Metal Cutting and Machine Tools”, Mc-Graw Hill, Volume 2, 4th Edition, 2018
4.	Hajra Choudhury, "Elements of Workshop Technology", Vol.I: Manufacturing Processes., Media Promoters & Publishers Pvt Ltd, 15th edition, 2012.

E-RESOURCES: (including NPTEL course)	
1.	https://archive.nptel.ac.in/courses/112/105/112105219/
2.	https://archive.nptel.ac.in/courses/112/107/112107219/
3.	https://archive.nptel.ac.in/courses/112/105/112105233/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3								3					
2	3								3					
3	3								3					
4	3								3					
5	3								3					

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

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS	
1.	Centre lathes 7 Nos.
2.	Arc welding machine 5 Nos.
3.	Gear shaper 1 No.
4.	Cylindrical grinding machine 1 No.
5.	Universal milling machine 1 No.
6.	Arc Welding setup
7.	Mould preparation tool sets

ME22314	MATERIAL TESTING LAB	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

1.	To supplement the theoretical knowledge gained in Mechanics of Solids and Material Characterization and Metallurgy subjects.
2.	Evaluate the mechanical properties of metallic materials by practical testing
3.	Analyze the microstructure of ferrous and non-ferrous materials using metallurgical microscope

LIST OF EXPERIMENTS

1.	Tension test on a mild steel rod
2.	Double shear test on Mild steel and Aluminum rods.
3.	Torsion test on mild steel rod.
4.	Impact test on metal specimen (Charpy & Izod)
5.	Hardness test on metals – Vickers Micro-hardness, Brinell and Rockwell Hardness Number.
6.	Deflection test on beams (Simply supported and Cantilever)
7.	Compression test on helical springs
8.	Strain Measurement using Rosette strain gauge
9.	Comparison of Mechanical properties of steel – using impact & hardness tests i. Unhardened specimen ii. Quenched Specimen and iii. Quenched and tempered specimen
10.	Microscopic Examination of i. Hardened samples and ii. Hardened and tempered samples

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Determine** the various mechanical properties of steel and non-ferrous materials like hardness, tensile strength and impact strength using Rockwell & Brinell hardness tester, universal testing machine and impact testing machine respectively.	3
CO2	**Evaluate** Young's modulus of steel & aluminum using simply supported and cantilever method	5
CO3	**Evaluate** stiffness and spring index of alloy spring steel using compression test	5
CO4	**Analyze** the microstructure of various heat treated steel, copper alloy and aluminum alloy using optical microscope	4
CO5	**Analyze** the medium carbon steel hardenability using Jomni end quench testing	4

REFERENCES:

1.	Strength of materials laboratory manual, Anna University, Chennai - 600 025.
2.	Strength of materials laboratory manual, IITM.

E-RESOURCES:

1.	VLABS - https://sm-nitk.vlabs.ac.in/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3								3					
2	3								3					
3	3								3					
4	3								3					
5	3								3					

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl.No	Item Description	Qty.
1.	Universal Tensile Testing machine with double shear attachment (40 Ton Capacity)	1
2.	Torsion Testing Machine (60 Nm Capacity)	1
3.	Impact Testing Machine (300 Nm Capacity)	1
4.	Brinell Hardness Testing Machine	1
5.	Rockwell Hardness Testing Machine	1
6.	Spring Testing Machine for tensile and compressive loads (2500 N)	1
7.	Muffle Furnace (8000°C)	1
8.	Vickers Micro-hardness Tester	1
9.	Deflection (Beam) testing setup – Simply supported & Cantilever	1
10.	Metallurgical Microscopes	2
11.	Metallurgical specimen polishing machine	1
12.	Rosette strain gauge setup	1
13.	Jomni End Quench Test setup	1

SEMESTER IV

GE22451	ENVIRONMENTAL SCIENCES AND SUSTAINABILITY (Common to all Branches)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To study the nature and facts about environment, energy flow in an ecosystem and biodiversity.
2.	To study the various types, causes of pollution, its control and solutions to environmental problems.
3.	To study and understand the various types of renewable sources of energy and its applications.
4.	To know the importance of sustainability management and practices
5.	To learn the importance of zero waste concept and green engineering for environmental management.

UNIT I	ENVIRONMENT AND BIODIVERSITY	9

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– food chains, food webs and ecological pyramids, ecological succession. Biodiversity- types-genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: fragmentation and habitat loss, poaching of wildlife, human-wildlife conflicts – endangered and endemic species of India –conservation of biodiversity: In-situ and ex-situ.

UNIT II	ENVIRONMENTAL POLLUTION	9

Definition, causes, effects and preventive measures of air, water and soil pollutions. Marine and thermal pollution - causes, effects and control measures. Nuclear pollution- Sources, effects and control measures. Disposal of radioactive wastes (Nuclear hazards). Pollution case studies. Role of an individual in prevention of pollution. Solid, hazardous and E-waste management. Occupational health and safety management system (OHASMS). Environmental protection, Environmental protection acts, categorization of spices according to IUCN.

UNIT III	RENEWABLE SOURCES OF ENERGY	9

Energy resources: Growing energy needs, Nonrenewable resources – types, uses. Energy management and conservation - New energy sources, Need of new sources - geo suitability of establishing renewable energy sources, different type's new energy sources. Applications of hydrogen energy, ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy. Role of an individual in conservation of energy.

UNIT IV	SUSTAINABILITY AND MANAGEMENT	9

Development, GDP, Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols, Sustainable Development Goals-targets, indicators and intervention areas - Principles of green chemistry, Climate change- Global, Regional and local environmental issues and possible solutions-case studies - Role of non-governmental organization, Concept of carbon credit, carbon footprint - Environmental management in industry-A case study

UNIT V	SUSTAINABILITY PRACTICES	9

Zero waste and R concept, circular economy, ISO 18000 series, material life cycle assessment,

environmental impact assessment. Wasteland reclamation, Sustainable habitat: green buildings, green materials, energy efficiency and energy audit, sustainable transports. Energy cycles, carbon cycle, emission and sequestration, Green engineering: sustainable urbanization- socio-economical and technological change. Rain water harvesting, watershed management environmental ethics: Issues and possible solutions.

TOTAL : 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Describe** the importance of ecosystems, biodiversity and its conservation.	3
CO2	**Classify** the different types of pollution, their effects and control measures.	4
CO3	**Implement** the energy management and conservation.	4
CO4	**Describe** the sustainable development, its importance and social issues like climate change	3
CO5	**Recognize** the importance of zero waste concept, circular economy, EIA and Green engineering for environmental management.	4

TEXTBOOKS:

1.	Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 7th Edition, NewAge International Publishers, 2022.
2.	Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3.	Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4.	Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5.	Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6.	Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7.	Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

REFERENCES:

1.	R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38
2.	Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3.	Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4.	Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 3rd edition, 2015.
5.	Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 3rd edition, 2021.

COURSE ARTICULATION MATRIX:														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3					3	3							
2	3					3	3							
3	3	1	1			3	3							
4	3					3	3	3				1		
5	3					3	3	3				1		
1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)														

MN22401	DESIGN OF MACHINE ELEMENTS AND TRANSMISSION SYSTEMS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

1.	To impart the knowledge on the design for static and fatigue strength of various machine elements.
2.	To make the students to understand the design principles of bearings and couplings
3.	To familiarize the design and analysis of welded joints and bolted joints.
4.	To provide knowledge on the principles and procedures for the design of flexible drive systems.
5.	To familiarize the standard procedure for design of cylindrical and non-cylindrical gear pairs.

UNIT I	**DESIGN FOR STATIC AND FATIGUE STRENGTH**	**14**

Types of design - design process – Types of stresses, Principal stresses, Theories of Failures- problems, Fatigue phenomenon theories. Introduction to Shaft – types of shaft - design of shaft. Standardization, preferred numbers.

UNIT II	**DESIGN OF BEARINGS AND COUPLINGS**	**10**

Types of bearings – Nomenclature – selection of rolling contact bearings for different industrial applications. Couplings - Types of couplings - Design of rigid flange coupling - Design of flexible coupling.

UNIT III	**DESIGN OF WELDING JOINT AND FASTENERS**	**12**

Types of welded joints, Nomenclature - Design of welded joint for circumference weld works - eccentrically loaded welded structures. Design of bolted joint for axial and eccentrical loaded conditions. Codes and standards for soldering process.

UNIT IV	**DESIGN OF FLEXIBLE DRIVES**	**10**

Flexible drive systems - types of flexible drives – design of V- Belt drives, design of chain drives.

UNIT V	**DESIGN OF GEAR DRIVES**	**14**

Gears - types of gears - nomenclature - classification of gear drives – design of helical gear drives - design of bevel gear drive. Speed reducer - Design of worm gear drive.

TOTAL: 60 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Analyze** the stresses induced in simple machine elements and shafts subjected to static and fatigue loading.	4
CO2	**Select** and design the required rolling contact bearing to support the given application.	3
CO3	**Design** the permanent and temporary joints subjected to direct and eccentric loading conditions.	4
CO4	**Apply** procedures to design the transmission elements like belt and chain drives.	3
CO5	**Apply** the design procedure for helical, bevel and worm gear drives to transmit power.	3

TEXTBOOKS:	
1.	Bhandari. V.B," Design of Machine Elements ", Fifth Edition McGraw Hill Education (India) Private Limited, , Noida 2020.
2.	Richard G. Budynas and Keith J. Nisbett "Shigley's Mechanical Engineering Design",11th edition, McGraw Hill,2020.
3.	Sharma P.C and D.K Sharma, "Machine Design", Agrawal - Kataria and Sons Publications. NewDelhi, 2014.
REFERENCES:	
1.	Dexter S Kimball and John H Barr ,"Elements of Machine Design", Maxwell Press,2022.
2.	Khurmi R.S.," A Textbook Of Machine Design ", 25th edition, S Chand, 2020.
3.	Robert C. Juvinall, Kurt M. Marshek," Machine Component Design ", Willey Indian Edition,2016.
4.	Robert L. Norton," Machine Design ", 5th Edition Pearson India ,2018.
E-RESOURCES:	
1.	http://www.nptelvideos.com/course.php?id=791& http://nptel.ac.in/courses/112105125
2.	https://www.expresslibrary.mheducation.com/product/design-machine-elements50161125
3.	https://www.machinedesign.com › basics-design › hydrodynamic-bearings
4.	https://fac.ksu.edu.sa › sites › default › files › mechanical-design-shigley.
5.	https://www.teacheron.com/design_of_machine_elements-tutors.

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	1						2	2		3	3	1
2	3	2	1						1			2	3	
3	3	2	1						2	1		1	3	1
4	3	2	1									1	3	
5	3	1	1						1			1	3	

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

MN22402	FLUID MECHANICS AND THERMAL SCIENCE	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

1.	To impart the basic knowledge of fluids in static, kinematic and dynamic equilibrium conditions.
2.	To gain the knowledge of the applicability of physical laws in addressing the problems of fluid flow.
3.	To enable the students for analyzing the various energy transferring / transforming equipment using first law of thermodynamics
4.	To familiarize the students to understand the fundamentals of thermodynamics using the second law and to perform thermal analysis.
5.	To impart the knowledge of primary techniques for cooling electronic devices and thermal management of equipment.

UNIT I	FLOW CHARACTERISTICS	12

Introduction to Fluid Mechanics. Pressure measurement using U-tube manometers. Flow characteristics – Concept of control volume and system - Reynold's transportation theorem - Continuity equation, energy equation and momentum equation – Applications- Orifice meter and Venturimeter.

UNIT II	FLOW THROUGH CIRCULAR CONDUITS	12

Hydraulic and energy gradient - Laminar flow through circular conduits and circular annuli-Boundary layer concepts – types of boundary layer thickness – Major and minor losses - Darcy Weisbach equation – friction factor- Moody diagram- Commercial pipes – Flow through pipes in series and parallel.

UNIT III	FIRST LAW OF THERMODYNAMICS	12

Basic concepts, System and their types, reversible and irreversible processes, Heat and work transfer, Zeroth law of thermodynamics– Concept of temperature and thermal equilibrium. First law of thermodynamics–application to non-flow and steady flow processes –unsteady flow processes (descriptive only).

UNIT IV	SECOND LAW AND PROPERTIES OF PURE SUBSTANCE	12

Heat reservoirs - Heat Engine, refrigerator and heat pump. Statements of second law and its corollaries - Clausius inequality. Concept of entropy, T-S diagram, T ds equations. Entropy change for ideal gases-different processes, principle of increase in entropy. Formation of steam and its thermodynamic properties, P-v, P-T, T-v, T-s, h-s diagrams - PVT surface. Use of Steam Table and Mollier Chart.

UNIT V	HEAT TRANSFER	12

Basic Concepts of Conduction, Convection and Radiation. Thermal management in Electronic and Mechanical devices. Thermoelectric cooling and its principles - Applications in electronic systems - Peltier effect of cooling in semiconductors - Cooling of automotive electronic devices - Trends in thermal management - Heat Pipe.

TOTAL: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Acquire a basic knowledge of fluids in static, kinematic and dynamic equilibrium.	3
CO2	Gain the knowledge of the applicability of physical laws in fluid flow through circular conduits.	3
CO3	Analyze various Energy Transferring / transforming equipment using First law of thermodynamics	3

CO4	Analyze various Energy Transferring / transforming equipment using Second law of thermodynamics and able to analyze the properties of steam with the help of steam table and charts.	4
CO5	Gain the Knowledge of necessity of cooling of electronic components and heat transfer methods, Thermoelectric cooling principles, applications in electronics systems.	3

TEXTBOOKS:

1.	Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi, 2019
2.	White, F.M., Henry Xue “Fluid Mechanics”, Tata McGraw Hill, 9th Edition, New Delhi, 2022.
3.	Nag P.K “Engineering Thermodynamics” 5th Edition, Tata McGraw-Hill, New Delhi 2013
4.	Nag, P.K., "Heat Transfer", Tata McGraw Hill, New Delhi,3rd edition 2011

REFERENCES:

1.	Jain A. K. "Fluid Mechanics", Khanna Publishers, 2010
2.	Yunus A. Cengel and Michael A.Boles “Thermodynamics Engineering approach”, 8th Edition Tata McGraw hill Publications. 2014
3.	Rajput R.K., “ Thermal Engineering”, Lakshmi Publications, Tenth Edition, 2017
4.	Younes Shabany, Heat Transfer: Thermal Management of Electronics, CRC Press; 2010

E-RESOURCES:

1.	https://nptel.ac.in/courses/112104118
2.	https://archive.nptel.ac.in/courses/112/105/112105171/
3.	https://onlinecourses.nptel.ac.in/noc23_me31/preview

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3		1										1	2
2	3	2	1										1	1
3	3	2	1										2	1
4	3	2	1										2	1
5	3		1										1	1

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

MN22403	OPERATIONS RESEARCH AND MANAGEMENT (Common to ME & MN)	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES:

1.	To provide knowledge and training in using optimization techniques under limited resources for engineering and business problems.
2.	To apply the concept of inventory and project management.
3.	To judge the suitable decision models for Industrial problems.

UNIT I	LINEAR MODELS	9

Phases of OR – Model - Definition – Types – Linear model Formulation - Graphical Solution Method – Branch and Bound Technique – Simplex Method - Two variable problems.

UNIT II	LOGISTICS AND ASSIGNMENT MODELS	9

Transportation model – Initial solution - Balanced and unbalanced models – Basic feasible Solution - North West corner method – Least Cost method – VAM - Optimality test – MODI method. Assignment model – formulation –Types.

UNIT III	PRODUCTION SCHEDULING AND NETWORK ANALYSIS	9

Flow shop scheduling – Johnson's algorithm processing n jobs through two machine problems - two jobs processed in 'm' machines – graphical method – Network models - Terminologies – EST – EFT – LST – LFT - Floats - Critical path method.

UNIT IV	QUEUING THEORY AND INVENTORY CONTROL	9

Queuing models - Queuing systems and structures – Notation parameter – Single server and multi-server models – M/M/1: FIFO/∞ – Inventory models – Economic order quantity models – Stochastic inventory models – Multi product models – Inventory control models in practice – Just in Time – Kanban systems - bins in modern industries.

UNIT V	MAINTENANCE AND DECISION MODEL	9

Types of Maintenance – Role of TPM – Depreciation – Replacement models – Items that deteriorate with time - When money value changes – Items that fail completely – Individual replacement and Group replacement – Game theory – Pure and mixed strategy – Dominance property – graphical method.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Recognize, formulate, and appraise LP models to optimize solutions for industrial scenarios.	4
CO2	Distinguish and apply the appropriate methodology for addressing real-time problems in the transshipment process	4
CO3	Appraise and select suitable methodologies for analyzing network problems.	4
CO4	Utilize and implement suitable techniques for solving production queuing problems.	3
CO5	Analyze a situation and propose appropriate decisions for replacement.	4

TEXTBOOKS:

1.	Panneerselvam. R., "Operation Research", Prentice Hall of India Pvt Ltd, 2016
2.	Taha H.A., "Operations Research", Tenth Edition, Prentice Hall of India, 2016

REFERENCES:

1.	Rama Murthy R, “Operations Research”,Second edition, New Age International Publisher, 2007
2.	Hira and Gupta “Problems in Operations Research”, S.Chand and Co.2008
3.	Wagner, “Operations Research”, Prentice Hall of India, 2000.

E-RESOURCES: (including NPTEL course)

1.	https://nptel.ac.in/courses/110/106/110106062/
2.	https://nptel.ac.in/courses/112/106/112106134/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1.	3	3	1	1								1	2	1
2.	3	2	1	1								1	2	1
3.	3	2	1	1	1							1	2	1
4.	3	2	1	1								1	2	1
5.	3	2	1	1								1	2	1

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

MN22408	HYDRAULICS AND PNEUMATICS FOR AUTOMATION: THEORY AND PRACTICES (Common to MN, ME)	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

1. To understand the fundamental principles and operations of hydraulic and pneumatic components.
2. To design fluid power circuits for industrial automation.

UNIT I	HYDRAULIC SYSTEM COMPONENTS	11

Fluid power systems - hydraulic fluids - Pascal's law - Darcy's equation – Losses in valves and fittings. Hydraulic power source - pumping theory – pumps classification - construction, working and selection. Hydraulic actuators – linear & rotary. Performance evaluation of hydraulic components.
Control components – directional, flow and pressure control - types, construction, operation and applications.

UNIT II	PNEUMATIC SYSTEM COMPONENTS	7

Compressors - types and working principle. Filter, Regulator, Lubricator, Muffler, Air control valves, Quick exhaust valves, Pneumatic actuators, Servo valves. Fluid power ANSI symbol.

UNIT III	FLUID POWER ACCESSORIES AND MAINTENANCE	9

Accessories - Accumulators and their applications, Pressure intensifier, Pressure switches, Electrical switches, Limit switches, Relays. Air-over oil system, Hydrostatic transmission.–Fault finding and maintenance of fluid power systems.

UNIT IV	DESIGN OF FLUID POWER CIRCUITS	9

Design of hydraulic and pneumatic circuits - Sequencing – Synchronization – Regenerative - Double pump circuit with unloading valve - Reciprocation of linear actuators. Speed control- meter-in & meter-out circuits. Sequential circuit design using cascade method.

UNIT V	LOW-COST AUTOMATION	9

Electronics in low-cost automation – PLC and Micro controller. Electro-hydraulic and Electro-pneumatic circuits. Servo systems. Automation of drilling, shaping, punching, pressing/forging operations, and materials handling systems using fluid power systems.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Describe** the working and **calculate** the performance of the hydraulic components.	2
CO2	**Explain** the working of components used in pneumatic systems.	2
CO3	**Describe** the working of accessories used in fluid power system.	2
CO4	**Design** a sequential circuit for given operation using Cascade method.	3
CO5	**Design** fluid power circuits for automation of different industrial operations.	3

TEXTBOOKS:

1. Anthony Esposito, Fluid Power with Applications, Pearson Education, 7th edition, 2009.
2. James L. Johnson, Introduction to Fluid Power, Delmar Thomson Learning, 2002.

REFERENCES: (min 3, max 5)

1.	Dudelyt, A Pease and John J.Pippenger, Basic Fluid Power, Prentice Hall, 1987.
2.	Majumdar, S.R., Oil Hydraulics Systems-Principles and Maintenance, Tata McGrawHill, 2001
3.	Majumdar, S.R., Pneumatic Systems-Principles and Maintenance, Tata McGraw-Hill, 2007.
4.	Micheal J, Pinches and Ashby, J.G., Power Hydraulics, Prentice Hall, 1989.
5.	ShanmugaSundaram, K.,Hydraulic and Pneumatic controls, S. Chand limited, 2006.

E-RESOURCES: (including NPTEL course)

1.	NPTEL Course - https://nptel.ac.in/courses/112105046/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	1											2	3
2	3													3
3	3													3
4	3		3							3			3	3
5	3		3							3			3	3

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

MN22409	METROLOGY AND INSTRUMENTATION: THEORY AND PRACTICES	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

1.	Recognize the basic principles involved in various measurements
2.	Device the instrumentation required for measurement of various process parameters.
3.	Enhance the sophistication of measurement processes by using various advanced measuring techniques.
4.	Apply the principles of measurements for various industrial applications.

UNIT I	INTRODUCTION TO METROLOGY, LINEAR AND ANGULAR MEASUREMENTS	10

Introduction to Metrology – Need – Precision and Accuracy, Errors in Measurements, Comparators – Mechanical, Electrical & Optical. Interchangeability - limits, fits and tolerances, Limit gauges, Taylor's principle of gauge design. Calibration, Sensitivity, readability & repeatability.

Linear measurement - Vernier calipers – Vernier height gauge- Vernier depth gauge - Micrometers – Digital calipers - Slip gauges.

Angular Measurement - Angular measuring instruments – Types – Bevel protractor, Spirit levels, Sine bar – Sine center – Sine table – Angle Dekkor - Autocollimator.

UNIT II	FORM & PROCESS PARAMETERS MEASUREMENT	10

Form Measurement - Measurement of surface finish – Surf Tester. Screw thread measurement – Minor diameter & Effective diameter – Two wire method. Gear measurement - Gear terminology - Errors in gears – Pitch & Tooth thickness measurement - Parkinson's gear tester.

Measurement of Force – Load cells – Hydraulic & Pneumatic load cells – LVDT. Basics of Torque & Power measurement. Flow measurement – Differential pressure flow meter, Magnetic flow meter – Ultrasonic flow meter. Temperature measurement - Thermocouples – Radiation pyrometer – Infrared temperature sensor

UNIT III	ADVANCES IN METROLOGY	10

Interferometry – Types of Interferometers – Michelson interferometer – NPL flatness interferometer. Laser metrology - Basic concept of lasers - Advantages of Laser – Laser Interferometers – Types – DC and AC lasers interferometer – Applications. Coordinate Measuring Machines - Types of construction – Probes. CNC CMM, Machine vision system – Image acquisition & Image processing.

LABORATORY COMPONENT

OBJECTIVES:

1.	To apply the instruments to measure the physical dimensions and process parameters

LIST OF EXPERIMENTS

0	Calibration of different instruments
1.	Linear measurements using vernier caliper and micrometer.
2.	Measurement of bore diameter using bore dial gauge and telescopic gauge.
3.	Angle measurement using bevel protector, sine bar and tool makers microscope.
4.	Measurement of gear features using gear tooth vernier caliper.
5.	Straightness and Flatness measurement using autocollimator.
6.	Linear measurement using CMM.
7.	Angular measurement using CMM.

8.	Measurement of force and torque using strain gauges and transducers.
9.	Pressure measurement using transducer.
10.	Temperature measurement using different instruments.

TOTAL: 60 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Understand** the working principles of linear and angular measuring instruments.	**2**
CO2	**Acquire** an overview of mechanical measurement systems and principle of instruments for motion and dimension measurement.	**2**
CO3	**Select** the suitable transducer to perform the real time measurements.	**3**
CO4	**Calibrate** the measuring devices suitable for industrial measurements.	**4**
CO5	**Use** the advanced systems for real time and industrial measurements.	**3**

TEXTBOOKS:

1.	Gupta. I.C., "Engineering Metrology", 7th edition, Dhanpatrai Publication, 2019.
2.	Jain R.K "Engineering Metrology", Khanna Publishers, 1st edition, 2021.

REFERENCES:

1.	A K Sawhney, "A Course in Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai & Co (p) Ltd, 2021
2.	Beckwith, Maragoni&Lienhard, "Mechanical Measurements", Pearson Education, 6th edition, 2007.
3.	Mahajan M, "Textbook of Metrology", Dhanpat Rai & Co (p) Ltd, 2012.
4.	R.K. Rajput, "Metrology and Instrumentation", S.K. Kataria& Sons, 2016
5.	Robert B. Northrop, "Introduction to Instrumentation and Measurements", CRC Press, 2018

E-RESOURCES:

1.	http://home.iitk.ac.in/~nsinha/Metrology.pdf
2.	https://nptel.ac.in/courses/112106179
3.	https://swayamprabha.gov.in/index.php/program_data/flipMore/M74/11

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2				2				2			2		
2	2	2	2		2	2				2			2	
3	2		2		2				2			2	2	2
4	3		3		3	3			3			2	3	3
5	2		2		3	2			2				2	2

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS		Qty.
1.	Micrometer	2
2.	Vernier Caliper	4
3.	Vernier Height Gauge	2
4.	Vernier Depth Gauge	2
5.	Slip Gauge Set	3
6.	Gear Tooth Vernier	2
7.	Sine Bar	2
8.	Floating Carriage Micrometer	1
9.	Profile Projector / Tool Makers Microscope	Each 1
10.	Mechanical / Electrical / Pneumatic Comparator	Each 1
11.	Autocollimator	1
12.	Temperature Measuring Setup	1
13.	Force Measuring Setup	1
14.	Torque Measuring Setup	1
15.	Coordinator Measuring Machine	1
16.	Surface finish measuring equipment	1
17.	Bore gauge	2 set
18.	Telescope gauge	2 set

MN22411	COMPUTER AIDED MODELLING LABORATORY (Common to ME & MN)	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

1.	Create 3D models of parts and assembly, and exploded views of assembly using CAD software.
2.	To provide knowledge on three-dimensional model of simple mechanism and animation using CAD software.
3.	To expose the knowledge to prepare the technical documents for the given components using software.

LIST OF EXPERIMENTS

1.	Introduction to modeling software and Study of Drawing Sheet Layout and Drawing Standards. Sketch, Solid modeling- Extrude, Revolve, Sweep.
2.	Solid modeling: Variational Sweep, Helical Sweep, Rotational Blend.
3.	Solid modeling: Blend and Parametric modeling- conversion of STL format.
4.	Surface modeling: Extrude, Sweep, Trim, Mesh of curves and Free form.
5.	Create a surface model of Aero Foil / Blower upper housing / Bend Pipe with flange.
6.	Construct a three-dimensional assembly model of Screw Jack. **
7.	Create a three-dimensional assembly model of Flange / Universal Coupling apply**
8.	Create a three-dimensional assembly model of kinematic mechanism and animate its working using modeling software.
9.	Introduction to Generative Design for Weight Reduction of a support frame.
10.	Generative Design for Weight Reduction of cycle frame.

**** Modelling of individual elements of the Mechanical equipment and assembling the same as per given standard by applying concepts of fits, limits, and tolerances – as Team exercises**

TOTAL 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Interpret the given 2D drawing and create a 3D part using 3D modeling software.	3
CO2	Create a 3D assembly in the assembly module using the 3D parts created in the part modeling module.	3
CO3	Generate 2D detailed drawing for the given parts & assembly models.	3
CO4	Analyze and interpret the kinematic links using 3D modeling software.	4

REFERENCES:

1.	Creo Parametric 4.0 Tutorials by Roger Too good, SDC Publications, 2017.
2.	Creo Parametric 4.0 for Designers BY Sham Tickoo, BPB Publications, 2018.
3.	Machine Drawing by K.R. Gopalakrishnan, 2018.
4.	Machine Drawing by K. L. Narayana, New Age Publications, 2012.

E-RESOURCES:	
1.	https://grabcad.com/tutorials/basic-creo-tutorials
2.	https://support.ptc.com/help/creo/creo_pma/r9.0/usascii/index.html#page/part_modeling/part_modeling/partmodeling.html#
3.	https://www.youtube.com/watch?v=bYKbYLfpk6k
4.	https://www.youtube.com/watch?v=gJLAM54Vf-w
5.	https://youtu.be/lhq-O5w6STU

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1.					3				2	2			2	
2.					3				2	2			3	
3.					3				2	2			3	
4.					3				2				3	

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS		**Qty.**
1.	Desktop computers with windows, 64-bit and 8GB	30
2.	PTC Creo parametric	30

MN22412	FLUID AND THERMAL ENGINEERING LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

1.	To gain the experimental knowledge in flow measurements using different devices.
2.	To study the various losses in pipes.
3.	To gain experimental knowledge in the performance characteristic of pumps and turbines.
4.	To study the Performance of petrol, diesel engine and steam generator and refrigeration system.
5.	To Study the characteristics of fuels/Lubricants used in IC Engine, performance of compressor.

LIST OF EXPERIMENTS

1.	Determination of the Coefficient of discharge of given Venturimeter and Orifice meter
2.	Determination of friction factor for a given set of pipes
3.	Conducting experiments and drawing the characteristic curves of centrifugal pump/ submersible pump
4.	Conducting experiments and drawing the characteristic curves of reciprocating pump
5.	Conducting experiments and drawing the characteristic curves of Gear pump
6.	Conducting experiments and drawing the characteristic curves of Pelton wheel
7.	Determination of viscosity and flash & fire point of fuels/Lubricants.
8.	Heat balance/retardation test on diesel engine.
9.	Performance test on diesel engine
10.	Performance test on air compressor
11.	Performance test on refrigeration system
12.	Determination of heat transfer coefficients.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Calculate the coefficient of discharge for the different flow measuring equipment.	3
CO2	Analyse the performance of various pumps and turbines.	4
CO3	Analyse the performance of diesel engine, refrigeration and compressor.	4
CO4	Determine the viscosity, flash and fire point of fuels/lubricants.	3

REFERENCES:

1.	Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi, 2019.
2.	Robert W.Fox, Alan T. McDonald, Philip J.Pritchard, “Fluid Mechanics and Machinery”, 2011
3.	Rajupt. R.K., "Thermal Engineering", Laxmi Publications, Tenth Edition, 2017
4.	Ganesan, V "Internal Combustion Engines", fourth Edition, Tata Mcgraw-Hill, 2012

E-RESOURCES:

1.	https://fm-nitk.vlabs.ac.in/List%20of%20experiments.html

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1.	3	3										3		3
2.	3	3										3		3
3.	3	3										3		3
4.	3	3										3		3
5.	3	3										3		3

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

	LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS	**Qty.**
1.	Venturi meter setup and Orifice meter setup	1
2.	Pipe Flow analysis setup	1
3.	Centrifugal pump setup	1
4.	Reciprocating pump setup	1
5.	Gear pump setup	1
6.	Pelton wheel setup	1
7.	Apparatus for Flash and Fire Point and viscometer	1
8.	4-stroke Diesel Engine with hydraulic loading	1
9.	Single cylinder Petrol Engine	1
10.	Steam Boiler setup	1
11.	Air compressor	1
12.	Refrigeration test rig	1

SEMESTER V

MN22501	INDUSTRIAL ROBOTICS: THEORIES FOR IMPLEMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	Understanding the fundamental principles and theories governing industrial robotics.
2.	Analyzing and implementing advanced robotic control strategies.
3.	Developing skills in programming and integrating industrial robots into manufacturing processes.

UNIT I	FUNDAMENTALS OF ROBOT TECHNOLOGY	9

Robot – Definition - Need for robots - Classification based on coordinate system - Control method – Work envelope. Robot motion – Types & joints, wrist – pitch, roll, yaw. Joint notation scheme, Robot specification. Drive system – Modeling and Control of a Single Joint Robot - Numerical Problems.

UNIT II	ROBOT MOTION ANALYSIS AND CONTROL	9

Manipulator Kinematics - Forward and Inverse - Denavit - Hartenberg (DH) parameters - Homogeneous Transformations - Robot Kinematics - Manipulator path: types and control - Robot Dynamics - Configuration of a robot controller - Numerical Problems

UNIT III	END EFFECTORS	9

End Effectors – Grippers – Mechanical grippers – Gripper mechanisms, Magnetic gripper, Vacuum gripper – Inflatable gripper; Internal and External gripper; Gripper selection – Tool as end effectors – Gripper force analysis.

UNIT IV	ROBOT PROGRAMMING	9

Methods of Robot Programming – Robot programming – Lead through – manual – Limitations – Textual robot languages – Structure - Motion commands - Program control and subroutines - Robot program as a path in space – Defining position in space – Reason for defining points – Speed control – Motion interpolation.

UNIT V	ROBOT CELL DESIGN AND APPLICATIONS	9

Robot cell layouts - Multiple robots and machine interference - work cell design and control - Interlocks - Error detection and recovery - Robot cycle time analysis - Safety in robots - Training and maintenance - Applications of Industrial robots in Manufacturing, Material handling, painting and welding.

TOTAL : 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Describe the fundamental principles and theories underlying industrial robotics.	**2**
CO2	Analyze and implement advanced control strategies for industrial robots.	**3**
CO3	Describe the types of End effector for various applications	**2**
CO4	Demonstrate proficiency in programming and simulating industrial robots.	**3**
CO5	Ensure the safety and proper maintenance of industrial robots in industrial settings.	**3**

TEXTBOOKS:

1. Nicholas Odrey, Mitchell Weiss, Mikell Groover, Roger Nagel, Ashish Dutta “Industrial Robotics -Technology, Programming and Applications”, 2nd Edition, 2017.

REFERENCES:

1.	Yoram Koren, "Robotics for Engineers", McGraw-Hill, 1985.
2.	Nikolaus Correll, “Introduction to Autonomous Robots”, Nikolaus Correll, 2016.
3.	King-Sun Fu, C. S. George Lee, Ralph Gonzalez, “Robotics: Control, Sensing, Vision and Intelligence”, McGraw-Hill Education, 1987.

E-RESOURCES:

1.	https://nptel.ac.in/courses/112105319
2.	https://nptel.ac.in/courses/112104298

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	2	1	1							1	2	2
2	3	3	2	1	1							1	2	2
3	3	3	2	1	2					1		1	2	2
4	3	3	2	1	2					1		1	2	2
5	3	3	2	1	2					1		1	2	2

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

MN22502	MODERN MANUFACTURING PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To impart CNC Programming skills in writing and interpreting CNC programs using industry-standard programming languages like G-code and M-code, enabling them to effectively control CNC machines.
2.	To impart principles and fundamental concepts of additive manufacturing processes and enrich the students with the ability to select appropriate materials and processes for specific additive manufacturing applications and make them analyze manufacturing challenges associated with additive manufacturing.
3.	To enable the students to acquire the knowledge and skills necessary to assess different laser machining processes and select the most suitable one for a given application.

UNIT I	MODERN CNC MACHINES	9

Introduction – Advantages of CNC Machines – CNC machining and turning center developments – Tool monitoring on CNC Machines – Design of Modern CNC Machines – Machine structure – Guideways – Feed drives – Spindle bearings – Measuring systems, Controls, Software, and user interface Gauging – Control panel for turning and machining center.

UNIT II	PROGRAMMING AND OPERATIONS OF CNC MACHINES	9

Introduction to part programming – Coordinate system – Dimensioning- Axes and motion nomenclature – Part program structure – G codes and M codes – linear and circular interpolation – Tool compensation -subroutines – canned cycles – Programming examples for machining and turning center.

UNIT III	INTRODUCTION TO ADDITIVE MANUFACTURING	9

Classification of AM processes – Materials for AM - Heat sources – AM standards – Steps in Additive manufacturing – VAT photopolymerization – Approaches – Materials - Continuous Liquid Interface Production (CLIP) Technology - Two-Photon Vat Photopolymerization – Powder bed fusion – Selective laser sintering – Process parameters and analysis: Applied energy correlations and scan patterns – Powder handling challenges, Systems – Powder recycling.

UNIT IV	OTHER AM PROCESSES	9

Wire arc additive manufacturing – Post process – Friction stir additive manufacturing (FSAM) – Process parameters – Benefits and drawbacks of DED Technology – Hybrid AM – Material issues in AM - Software for AM – Manufacturing Vs Prototyping - Direct Digital Manufacturing – Applications of Direct Digital Manufacturing.

UNIT V	LASER MANUFACTURING	9

Laser drilling, piercing – Laser welding – process mechanism -operating characteristics - Laser welding of plastics -Applications of laser welding –Laser safety – Dangers – Standards.

TOTAL : 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level

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

CO1	**Explain** constructional features and **operate** CNC machines, including machine datum setting, workpiece clamping, and machine calibration.	3
CO2	**Analyze** and **interpret** the given part diagram and write CNC programs using G-codes and M-codes.	5
CO3	E**xplain** the principles, fundamental concepts, challenges and **select** suitable materials for photopolymerization and powder bed fusion additive manufacturing processes.	3
CO4	E**xplain** the principles and **choose** suitable materials for wire arc, friction stir, DDM and hybrid AM and **select** a process for the given application.	3
CO5	**Select** suitable laser machining process for the given application.	3

TEXTBOOKS:

1.	Serope Kalpakjian & Steven R. Schmid, "Manufacturing Engineering and Technology", Pearson India Education Services Pvt. Ltd, 8e in SI units , 2023.
2.	HMT, "Mechatronics" McGrawHill, 2018.
3.	SK Sinha, "CNC programming (FANUC control)", Galgotta, 2022.

REFERENCES:

1.	Ian Gibson, David Rosen,brent stucker, Mahyar Khorasani, "Additive Manufacturing Technologies", Springer, 3rd edition, 2020.
2.	Fanuc series oi-model F, Operator's Manual.
3.	William M. Steen, Jyotirmoy Mazumder, "Laser Material Processing", Springer, 4th edition, 2010

E-RESOURCES:

1.	https://archive.nptel.ac.in/courses/112/103/112103293/
2.	https://archive.nptel.ac.in/courses/112/105/112105211/
3.	https://archive.nptel.ac.in/courses/112/103/112103306/

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3				3				1	1		1		3
2	3	3		3	3				1	1		1		3
3	3				3	1			1	1		1		3
4	3				3	1			1	1		1		3
5	2				1					1		1		3

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

ME22403	THERMAL ENGINEERING	L	T	P	C
		2	1	0	3

(Use of standard refrigerant property data book, Steam Tables, Mollier diagram and Psychrometric chart permitted)

COURSE OBJECTIVES:

1.	To integrate the concepts, laws, and methodologies from the first course in thermodynamics into analysis of cyclic processes.
2.	To understand the working principles of advanced IC Engines and evaluate its performances.
3.	To apply the thermodynamic concepts into various thermal applications like Steam nozzles, Steam turbines, Compressors, Refrigeration and Air conditioning systems.

UNIT I	FUNDAMENTALS OF IC ENGINES AND GAS POWER CYCLES	9

Working principles of IC engines. Classifications-Components and their functions. Valve timing diagram and port timing diagram - actual and theoretical p-V diagram of four stroke and two stroke engines. Otto, Diesel, Dual, Brayton cycles - Calculation of mean effective pressure and air standard efficiency, Comparison of cycles.

UNIT II	INTERNAL COMBUSTION ENGINES SYSTEM AND PERFORMANCE	9

Simple Carburetor, MPFI, Diesel pump and injector system, CRDI. Battery and Magneto Ignition System - Principles of Combustion and knocking in SI and CI Engines. Lubrication and Cooling systems. Performance calculations -Fuel consumption, Brake power, Indicated power, Friction power, Thermal efficiencies, and Heat Balance sheet.

UNIT III	STEAM NOZZLES AND TURBINES	9

Flow of steam through nozzles, shapes of nozzles, effect of friction, critical pressure ratio, super saturated flow. Impulse and Reaction principles, compounding, velocity diagram for simple and multi-stage turbines, speed regulations– Governors.

UNIT IV	AIR COMPRESSORS	9

Classification and working principle of reciprocating compressors - compression work with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency of reciprocating compressors, Multistage air compressor and intercooling – work done. Working Principle of different types of rotary compressors (descriptive only).

UNIT V	REFRIGERATION AND AIR CONDITIONING	9

Refrigeration -Vapour compression refrigeration cycle - Effect of super heating and subcooling – Performance calculations – working principle of Vapour absorption system, Ammonia–Water, Lithium bromide–water systems (descriptive only). Air conditioning system - Processes, Types and Working Principles –Concept of RSHF, GSHF, ESHF- Cooling load estimation (descriptive only). Refrigerants – desirable properties, refrigerants used in modern Refrigerators and Air conditioners.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, Students will be able to		
CO1	Compare the various system & components of IC engine and to analyze their performance of air standard cycles.	4
CO2	Understand the various system used in IC engine and to analyze their performance.	4
CO3	Distinguish the different types of nozzles and turbine, and to analyze their performance.	4
CO4	Distinguish the different types of air compressor and to analyze their performance.	4
CO5	Analyze the performance of different air conditioning and Refrigeration system.	4

TEXTBOOKS:

1.	Kothandaraman. C.P., Domkundwar. S, Domkundwar. A.V., "A course in Thermal Engineering", Fifth Edition, Dhanpat Rai & Sons,2002
2.	Rajput. R.K., "Thermal Engineering", Laxmi Publications, Tenth Edition, 2017.

REFERENCES:

1.	Arora. C.P, "Refrigeration and Air Conditioning",Tata McGraw-Hill Publishers, (Third Edition) 2013.
2.	Ganesan.V, "Internal Combustion Engines", Third Edition, Tata McGraw-Hill, 2007.
3.	Ramalingam. K.K.,"Thermal Engineering", SCITECH Publications (India) Pvt. Ltd., 2009.
4.	Rudramoorthy. R.,"Thermal Engineering", Tata McGraw-Hill, New Delhi, 2003.
5.	Sarkar. B.K, "Thermal Engineering", Tata McGraw-Hill Publishers, 2007.

E-RESOURCES:

1.	https://nptel.ac.in/courses/112106133
2.	https://nptel.ac.in/courses/112103262
3	https://www.youtube.com/watch?v=ZBfmj4PRoRA
4	https://archive.nptel.ac.in/courses/112/105/112105129/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	3	3									2	
2	3	3	3	3									2	
3	3	3	3	3									1	
4	3	3	3	3									2	
5	3	3	3	3									2	

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

ME22709	COMPUTER AIDED ENGINEERING: THEORY AND PRACTICES (Common to ME and MN)	L	T	P	C
		1	0	4	2

COURSE OBJECTIVES:

1.	Understand the fundamental principles and significance of computer-aided engineering (CAE) in modern engineering practices.
2.	Gain proficiency in utilizing CAE software tools for design, analysis, and optimization of engineering systems and components.
3.	Develop the ability to apply CAE methodologies to solve practical engineering problems related to stress analysis, heat transfer, fluid dynamics, and structural dynamics.
4.	Enhance critical thinking and problem-solving skills by interpreting CAE simulation results, optimizing engineering designs for Industrial needs.

UNIT 0	INTRODUCTION (EXCLUDED FOR EXAMINATION)	3

Historical background – Classical Techniques in FEM – Discretization - Weighted residual method – Rayleigh Ritz method

UNIT I	MEMBERS SUBJECTED TO FLEXURAL LOADS	12

One Dimensional problems: Bar, Truss, Beam, steady state conduction heat transfer problems
Two Dimensional problems: Plane stress, Plane strain and Axisymmetric problems in CST elements – Iso-parametric elements – Gauss Integration

LABORATORY COMPONENT

LIST OF EXPERIMENTS	60

1.	Force and Stress analysis using link elements in Trusses, cables etc
2.	Stress and deflection analysis in beams with different support conditions.
3.	Stress analysis of flat plates and simple shells
4.	Stress analysis of axisymmetric components
5.	Thermal stress and heat transfer analysis of plates
6.	Thermal stress analysis of cylindrical shells
7.	Vibration analysis of spring-mass systems.
8.	Modal analysis of beam.
9.	Harmonic, transient and spectrum analysis of simple systems
10.	Optimization to improve the design of a mechanical component based on strength to weight ratios
11.	Simulation of fluid flow through a pipe or around an airfoil to study velocity profiles, pressure distributions, and flow patterns

TOTAL: 75 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Students will understand and apply the concepts of Finite Element Method (FEM)	3

	Fundamentals	
CO2	Students will analyze Structural Members and Thermal Systems Using FEM	4
CO3	Students will perform Stress, Modal, and Vibration Analysis with FEM	4
CO4	Students will apply FEM for Optimization and Fluid Flow Simulation	4

TEXTBOOKS:

1.	Bansal, R.K., "A Textbook of Strength of Materials", Laxmi Publications (P) Ltd., 2018
2.	Jindal U.C., "Strength of Materials", Asian Books Pvt. Ltd., New Delhi, 2009

REFERENCES

1.	Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2017
2.	Ferdinand P. Beer, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", McGraw Hill Education,8th edition, 2019
3.	Rattan, “Strength of Materials”, McGraw Hill Education, 3rd Edition, 2017
4.	Egor. P.Popov “Engineering Mechanics of Solids” Pearson, 2010

E-RESOURCES:

1.	https://nptel.ac.in/courses/112107146
2.	https://nptel.ac.in/courses/112106141
3.	https://archive.nptel.ac.in/courses/105/105/105105108/

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	**3**	**3**											**1**	**2**
2	**3**	**3**	**3**		**3**								**1**	
3	**3**	**3**	**3**		**3**								**2**	
4	**3**	**3**	**3**		**3**								**2**	

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

MN22509	CONTROLLERS FOR AUTOMATION: THEORY AND PRACTICES (Common to ME & MN)	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

1.	Gain knowledge of PLC programming, including ladder logic, function block diagrams, and structured text, to design, and implement it for industrial automation.
2.	Explore the architecture and functionalities of Micro controller and SCADA systems for industrial applications.
3.	Gain hands-on experience in HMI design and implementation for diverse industrial processes and applications.

UNIT I	PLC AND MICRO CONTROLLERS	10

PLC Fundamentals - CPU, memory, I/O modules, timers, counters, registers. PLC Programming - Ladder Logic, Function Block Diagrams, Structured Text, Run/Stop/Program modes, scanning, Micro controllers – Hardware - I/O interfacing, sensor data acquisition, actuator control, implementing control logic, Industrial communication protocols of PLC and micro controller, Applications in industrial automation.

UNIT II	HMI	08

Introduction - Different Types of Operator Interfaces – Textual and Graphical - Wiring practice and data handling - Configuration and Interfacing to PLC and PC - Communication Standards. display data (temperatures, production rates), receive operator input (start/stop buttons).

UNIT III	SCADA AND DCS	12

SCADA introduction - Role of SCADA in Industrial Automation - SCADA System Configuration – Remote Terminal Unit - Communication Protocols - Script Programming - Real Time and Historical Trend - Configuring Alarms - Real Time Project Development with PLC Interfacing - Communication with Other Software. DCS – Architecture - Yokogawa Centum CS 3000 - Comparison of PLC with DCS - Programming Languages for DCS - Different Types of cards and their functions.

LABORATORY COMPONENT

LIST OF EXPERIMENTS

1.	Create simple programs to control motor starters, lights, and other basic industrial equipment using timers and counters.
2.	Interface PLC with analog sensors and actuators to execute the sequential operations.
3.	Develop a PLC program to automate the operation of a conveyor belt system, including starting, stopping, and speed control and palletizing the objects.
4.	Develop and configure communication protocols using SCADA screens to monitor and control industrial processes in real-time
5.	Use the SCADA software to monitor real-time operations of sensors, camara in industrial automation.
6.	Demonstrate how operators can monitor and control industrial operations remotely using the SCADA interface.
7.	Create a basic HMI screen with buttons, indicators, and numeric displays to control and monitor a simulated industrial process.
8.	Implement production reporting features in the HMI system to track production counts,

	downtime events, and quality metrics.
9.	Implement duty cycle modulation to achieve variable speed and position control in industrial applications.
10.	Implement the microcontroller to execute control algorithms, manage peripheral devices, and communicate with external systems to perform specific tasks autonomously.

TOTAL: 60 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand the fundamentals of PLC, Micro Controller, SCADA, and HMI systems.	3
CO2	Configure SCADA applications to acquire, process, and visualize real-time data from industrial processes.	3
CO3	Design and implement effective automation solutions	4
CO4	Evaluate emerging trends and advancements in PLC, Micro Controller, SCADA, and HMI technology	4

TEXTBOOKS:

1.	Kamel, Khaled, and Eman Kamel. Programmable logic controllers: Industrial control. McGraw Hill Professional, 2013.
2.	K S Manoj, Power System Automation: Build Secure Power System SCADA & Smart Grids, Notion Press 2021.

REFERENCES:

1.	Jack, Hugh. Automating Manufacturing Systems with PLCs. United Kingdom, Lulu.com, 2009.
2.	Barati Mobarakeh, Mohammad Hossein. DCS Distributed Control System. Independent Publishing Platform, 2017.
3.	Guccione, S., McKirahan, J. Human Machine Interface: Concepts and Projects. United States: Industrial Press Inc. 2016.

E-RESOURCES:

1.	https://nptel.ac.in/courses/108105088
2.	https://www.slideshare.net/slideshow/basics-of-automation-plc-and-scada/41794488
3.	https://www.manufacturingtomorrow.com/article/2022/01/human-machine-interface-hmi-and-its-importance-in-industrial-automation/18191

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1.	3	2	1									1	1	2
2.	3	2	1									1	1	2
3.	3	2	1									1	1	1
4.	3	3	3	2	3							2	1	2
	1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)													

MN22511	MODERN MANUFACTURING PROCESSES LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

1.	To impart the basics of CNC programming software.
2.	To impart the basics machining skills in CNC turning center and Vertical Machining Center.
3.	To inculcate the role planning and slicing in additive manufacturing process.

LIST OF EXPERIMENTS:

1.	Facing, simple turning and step turning
2.	Taper turning and circular interpolation
3.	Thread cutting
4.	Profile milling – Linear and circular interpolation
5.	Drilling and tapping
6.	Mirroring
7.	Modelling of an engineering component and creation of STL file
8.	Slicing and study of effects of process parameters
9.	Planning of supports on overhanging components
10.	3D printing of an engineering component using FDM technique
11.	3D printing of an engineering component using SLA technique
12.	Fabrication of an engineering component using Wire-Arc Additive Manufacturing

TOTAL:60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Showcase their skills in setting machine datum, employing appropriate techniques for workpiece clamping, and conducting precise machine calibration procedures and proficiently **operate** them.	3
CO2	**Analyze** the given part diagram and **generate** CNC programs utilizing G-codes and M-codes and **execute** the CNC programs in CNC machines.	4
CO3	Design and develop engineering components using different additive manufacturing techniques.	3

REFERENCES:

1.	Fanuc series oi-model F, Operator's Manual.
2.	HMT, "Mechatronics" McGrawHill, 2018.
3.	Additive Manufacturing laboratory manual prepared by department of Mechanical Engineering, SVCE.

E-RESOURCES:

1.	https://archive.nptel.ac.in/courses/112/103/112103293/
2.	https://archive.nptel.ac.in/courses/112/105/112105211/
3.	https://ultimaker.com/software/ultimaker-cura/#downloads

COURSE ARTICULATION MATRIX:														
COs	**Pos**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1.	**3**				**3**				**2**	**2**		**1**		**3**
2.	**3**	**3**			**3**				**2**	**2**		**1**		**3**
3.	3				3				3	3		3		3
1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)														

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

SL.No.	ITEM DESCRIPTION	Qty.
1.	SEENC turn software	5
2.	SEENC mill software	5
3.	CNC Turning Center	1
4.	Vertical Machining Center	1
5.	FDM 3D printers	3
6.	SLA 3D printers	2
7.	Curing equipment	1
8.	Desktop computers	4
9.	3D printing software	5
10.	Assorted finishing tools	2 sets

MN22512	ROBOTICS LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

1.	To understand the construction and components of a robot
2.	To learn robotic programming and employ robot to carryout various tasks

LIST OF EXPERIMENTS:

0	Study of robot's configuration
1.	Operating a robot using teach pendant
2.	Introduction to robot programming
3.	Robot programming using linear interpolation
4.	Continuous path programming
5.	Circular interpolation programming
6.	Conditional programming using IF statement
7.	Conditional programming using FOR loop
8.	Robot path programming using precision function
9.	Pick and place using TLP
10.	Pick and place by pallet command
11.	Colour sorting
12.	Size sorting

TOTAL: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Operate the robot using teach pendant	3
CO2	Program the robot on different paths	3
CO3	Program and operate the robot to perform the desired task	3

REFERENCES:

1.	Mitsubishi Electric Industrial Robot - RV-8CRL Standard Specifications manual
2.	Lab Manual prepared by department of Mechanical Engineering, SVCE

E-RESOURCES:

1.	https://www.mitsubishielectric.com/fa/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1.	3				3	3			3	3		3		3
2.	3				3	3			3	3		3		3
3.	3				3	3			3	3		3		3

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS		
SL.No.	**ITEM DESCRIPTION**	**Qty.**
1.	6 axis robot with teach pendant	01
2.	Robot programming software license	10
3.	Conveyor system with camera and sensors	01
4.	Air compressor	01
5.	Desktop computer	10
6.	UPS	As required

SEMESTER VI

MN22601	MODERN MATERIAL HANDLING SYSTEMS (Common ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Explore modern material handling systems (MHS) integrated with automation technologies.

UNIT I	**INTRODUCTION TO MODERN MHS**	9

Fundamentals of material handling, Evolution of material handling systems, Role of Automation in material handling, Safety and regulatory considerations, Conveyors and Carousels.

UNIT II	**AUTOMATED GUIDED VEHICLES**	9

Overview and classification of AGVs, Navigation and control systems, Integration with material handling systems, Applications, and case studies.

UNIT III	**AUTOMATED STORAGE AND RETRIEVAL SYSTEMS**	9

Introduction to AS/AR Systems, Types, Design considerations and Layout Planning, Warehouse Optimization with AS/AR Systems.

UNIT IV	**SORTING SYSTEMS**	9

Principle of sorting, Importance of sorting systems, Mechanical sorting systems - Belt, Roller and Pusher sorter, Automated Sorting – Automated conveyor sorting, AGV sorting and Robotic sorting. Integration – warehouse management, conveyor systems and AS/RS. Case studies and applications.

UNIT V	**OVERHEAD HOIST SYSTEMS**	9

Principles of overhead hoist systems, Types - Electric, Manual, Pneumatic. Components, Factors Influencing hoist system design, Installation Requirements and Best Practices, Safety standards and regulations, Operating procedures, Routine maintenance and inspections, Troubleshooting Common Issues, Applications in Mechanical Industries, Case Studies of successful implementations

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Explain the material handling systems using automated conveyors and carousels	2
CO2	Navigate and control of AGVs for handling different materials	2
CO3	Describe the integration of automation of material sorting, storage and retrieval in warehouses	2
CO4	Illustrate the types and application of overhead hoist systems in materials handling	2
CO5	Analyze relevant case studies in modern material handling systems used in various industries and report the implementation, applications, safety standards and regulations.	3

TEXTBOOKS:

1.	Automation, Production Systems, and Computer-Integrated Manufacturing, Mikell P Groover, Pearson Education, New York, 2021.
2.	Materials Handling Handbook, Raymond A. Kulwiec, John Wiley & Sons, Inc., ISBN:9780471097822
3.	Fundamentals of Robot Technology: An Introduction to Industrial Robots, Teleoperators and Robot Vehicles, ISBN 9789401167703, Kogan Page Ltd. 2013

REFERENCES:

1.	Automated Mechanical Sorting Device for Mixed Household Wastes, Razali Zol Bahri, Madasamy Gunasegaran, Lambert Academic Publishing, India, 2013, ISBN: 978-3659335792.
2.	Bulk Materials Handling Handbook, Jacob Fruchtbaum, Springer Newyork, ISBN978-1-4757-4695-2

E-RESOURCES:

1.	https://www.conveyco.com/blog/pros-cons-popular-sortation-systems/
2.	https://www.falconautotech.com/sortation-solutions/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2									3				3
2	2				2	2				3		3		3
3	2				2	2				3		3		3
4	2				2	2				3		3		3
5	2				2	2		1		3		3		3

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

MN22608	INDUSTRIAL INTERNET OF THINGS: THEORY AND PRACTICES (Common to ME and MN)	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

1.	To introduce the foundational concepts and principles of Industrial Internet of Things.
2.	To familiarize with the key technologies and protocols used in IIoT deployments.
3.	To enable students to analyze and design IIoT solutions for real-world applications.

UNIT I	INTRODUCTION	8

Definition and Scope of IIoT - Understanding the Difference Between IIoT and IoT - Key Components and Technologies - Sensors and Actuators - Connectivity Protocols - Edge and Fog Computing - Cloud Platforms and Services - Applications and Use Cases of IIoT in Various Industries

UNIT II	ARCHITECTURE AND IMPLEMENTATION	12

Architectural Layers of IIoT - Design Considerations: Interoperability, Scalability, Security and Privacy - Challenges in IIoT Implementation - System Integration - Data Management and Governance - Standardization and Regulation - Implementation Strategies - Prototyping and Proof of Concepts - Pilot Deployments - Full Deployment - Data Analytics and Insights - Continuous Monitoring and Maintenance.

UNIT III	NETWORK PROTOCOLS	10

Protocols in Data Communication – Requirements: Power and Latency - Common IIoT Network Protocols – MQTT – CoAP - HTTP/HTTPS – AMQP – DDS – LoRAWAN - Sensor Data Transmission - Command and Control Applications - Real-Time Monitoring and Alerting - Performance Metrics - Security Features - Integration with Existing Systems.

LABORATORY COMPONENT

LIST OF EXPERIMENTS:

1.	Simulation of the light emitting diode
2.	Simulation of the traffic light ambience
3.	Simulation of the light emitting diode with a push button
4.	Simulation of the buzzer
5.	Controlling the light emitting diode
6.	Ultrasonic sensor interfacing with the microcontroller
7.	Temperature and Humidity measurement
8.	Detection System with Ultrasonic Sensor
9.	Directional Control of the DC motor
10.	Data acquisition using the cloud database

TOTAL: 60 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Analyze the impact of IIoT technologies on industrial processes and operations.	3
CO2	Appraise the significance of the IIoT architecture to enhance the performance metrics.	3
CO3	Evaluate the effectiveness of different IIoT network protocols and communication technologies in industrial settings.	3
CO4	Investigate the simulation results and interpret data generated by virtual IIoT devices.	4
CO5	Design and implement IIoT solutions for specific industrial applications, considering factors such as scalability and interoperability.	4

TEXTBOOKS:	
1.	Introduction to IoT by S. Misra, A. Mukherjee, and A. Roy, Cambridge University Press, 2020.
2.	Learning Internet of Things by Peter Waher, 1st Edition, Packt Publishing, 2015.
REFERENCES:	
1.	Practical Industrial Internet of Things Security: A Practitioner's Guide" by Sravani Bhattacharjee, 1st Edition, Packt Publishing, 2018.
2.	S. Misra, C. Roy, and A. Mukherjee, 2020. Introduction to Industrial Internet of Things and Industry 4.0. CRC Press.
3.	Designing the Internet of Things - Adrian McEwen & Hakim Cassimality. Wiley India, ISBN: 9788126556861.
E-RESOURCES: (including NPTEL course)	
1.	https://onlinecourses.nptel.ac.in/noc22_cs53/preview

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1.	3	2	1									1	1	2
2.	3	2	1									1	1	2
3.	3	2	1									1	1	1
4.	3	3	3	2	3							2	1	2
5.	3	3	3	3		2	2	2	2	2		2	1	2

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

MN22609	PROGRAMMING AND MODELLING IN INDUSTRIAL AUTOMATION: THEORY AND PRACTICES	L	T	P	C
		1	0	4	3

COURSE OBJECTIVES:

1.	Master the use of Python, Arduino, and MATLAB for industrial automation tasks.
2.	Develop programming skills to control hardware devices and create automation scripts.
3.	Learn to model and simulate industrial processes using MATLAB
4.	Apply theoretical knowledge to design and execute complex industrial automation projects

UNIT I	PYTHON FOR INDUSTRIAL AUTOMATION	7

Basics of Python Programming, Data types - integers, floats, strings, lists, tuples, dictionaries, Types of operators, Loops, Variables, Functions - Setting up programming environment - Numpy library - File I/O, exception handling, object-oriented programming. Automation Scripts for File Management and Data Processing - Using Python to Access and Manipulate Database Records - Implementing TCP/IP Protocols in Python for Industrial Applications.

UNIT II	MATLAB FOR MODELLING AND SIMULATION	8

Introduction to MATLAB, Syntax, Variables, Functions, and Scripts - Control structures and loops - Curve fitting and interpolation – Visualizing Plots and graphs - Optimization techniques. Simulink and its applications.

LABORATORY COMPONENT

LIST OF EXPERIMENTS

1.	Working with Arrays/Matrix in python.
2.	Projectile Motion using python
3.	Analysis of Beams - Shear force and Bending Moment Diagrams using python
4.	Analyse the Diesel Cycle with python Program.
5.	Quarter Car Suspension Model with Python.
6.	Braking Force Calculations using MATLAB
7.	Aerodynamic Drag Force using MATLAB
8.	Bending Stress calculations and Plotting using MATLAB
9.	SimPlotting Shear force and Bending Moment Diagram using MATLAB
10.	Calculate stresses of a thin-cylinder using MATLAB
11.	Detecting bottle fill level using python programming
12.	Model and Control Robot Dynamics to Automate Virtual Assembly Line using MATLAB

TOTAL: 75 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Apply** Python programming concepts and Numpy library.	3

CO2	**Analyze** mechanical systems using Python, including projectile motion, beam analysis, Diesel cycle simulation, and suspension modeling.	4
CO3	**Design** MATLAB scripts for modeling, simulation, and optimization of engineering problems.	4
CO4	**Simulate** engineering scenarios using MATLAB, including braking force calculations, aerodynamic drag force, and bending stress analysis	3
CO5	**Design** the virtual industrial automation systems using MATLAB	4

TEXTBOOKS:

1.	McKinney, Wes. Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython. United States: O'Reilly Media, 2017.
2.	Moore, Holly. Matlab for Engineers. United Kingdom, Pearson Education, Limited, 2011.

REFERENCES:

1.	Sweigart, Al. Automate the Boring Stuff with Python, 2nd Edition: Practical Programming for Total Beginners. United States: No Starch Press, 2019.
2.	Bober, William. MATLAB® Essentials: A First Course for Engineers and Scientists. United States: CRC Press, 2017.

E-RESOURCES:

1.	Yarpiz - Academic Source Codes and Tutorials - https://yarpiz.com
2.	MATLAB Central - https://in.mathworks.com/matlabcentral/

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1														
2														
3														
4														
5														

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

SLNo.	**ITEM DESCRIPTION**	**Qty.**
1.	PC with Windows 10, Intel or AMD x86-64 processor with two or more cores, Ram 8GB (minimum)	30
2.	Python 3.10 or above	30
3.	MATLAB 2022 or above	30

MN22611	FACTORY SIMULATION LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

1.	To understand the different toolboxes of factory simulation software.
2.	To learn the factory simulation techniques and employ the same to design and simulate the different industrial operations.

LIST OF EXPERIMENTS:

1.	Modeling and Simulation of workstations and robots
2.	Modeling and Simulation of storage systems
3.	Modeling and Simulation of material handling devices– Conveyors, AGV, Overhead Hoist
4.	Modeling and Simulation of material handling devices – Robots.
5.	Modeling and Simulation of manufacturing control systems
6.	Modeling and Simulation of assembly line
7.	Modeling and Simulation of testing & inspection center
8.	Modeling and Simulation of packaging line
9.	Modeling and Simulation of manufacturing factory layout
10.	Modeling and Simulation of food processing industry layout
11.	Modeling and Simulation of supply chain network
12.	Modeling and Simulation of material flow analysis in manufacturing industries

TOTAL: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Demonstrate proficiency in modeling and simulating manufacturing and supply chain systems using various software toolboxes.	3
CO2	Interpret the simulation results to identify various metrics in the manufacturing processes, such as cycle time etc.	3
CO3	Communicate simulation findings, insights, and recommendations for effective operations.	3

REFERENCES:

1.	Modeling, Simulation, and Control of Flexible Manufacturing, MengChu Zhou & Kurapati Venkatesh, Worl Scientific Publisher, 1999.
2.	Visual Components Laboratory manual prepared by Department of Mechanical Engineering, SVCE

E-RESOURCES:

1.	https://www.visualcomponents.com/resources/#/ebook

COURSE ARTICULATION MATRIX:														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1.	3		3		3				3	3		3		3
2.	3	2	3	1	3		2		3	3	2	3		3
3.	3		3		3	2	2		3	3	2	3		3
1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)														

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

SL.No.	ITEM DESCRIPTION	Qty.
1.	Desktop computer with Windows 10, Intel or AMD x86-64 processor with two or more cores, Ram 16GB (minimum)	30
2.	UPS	As required
3.	Visual Components software license	30

HS22511	INTERVIEW & CAREER SKILLS LABORATORY	L	T	P	C
		0	0	3	2

COURSE OBJECTIVES:

1.	Build confidence and develop learners' language proficiency
2.	Create skills to better learners' performance in competitive examinations.
3	Improve learners' employability skills.
4	Develop entrepreneurship skills.
5.	Expose learners to the use of professional English.

UNIT I	LISTENING AND SPEAKING SKILLS	12

Conversation Skills – types small talk, face to face and telephonic, formal and informal conversations – skills in presenting ideas and collating information during conference calls (one –to one and technical group / team) – academic and workplace situations – conversing with faculty/visiting faculty/guests/officials/employers and employees – group discussion – etiquette and dos and don'ts, turn taking –presentation skills – seminars and projects using digital tools; mock interview – etiquette and dos and don'ts – audio-visual interface for enhancement of listening and speaking skills. IELTS and TOEFL (Listening related exercises)

UNIT II	READING / SPEED READING, CRITICAL THINKING AND WRITING SKILLS	12

Reading Comprehension – general and scientific texts/articles/case studies from different or relevant fields of study for analysis and critical thinking; employability skills – writing job applications – cover letter accompanying résumé – types of business letters and email writing and etiquette; writing reports – statement of purpose – writing articles for publication style and format – creating blogs or company profiles – speed reading of voluminous reports / documents and exacting necessary information and abstract preparation including dissemination. IELTS and TOEFL(Reading related exercises)

UNIT III	ENGLISH FOR PROFESSIONAL EXAMINATIONS	12

Sentences, paragraphs and reading comprehension – vocabulary building – general and technical terms – contextual meaning – spelling – subject specific words – usage and user specific terminology. IELTS and TOEFL(Grammar and verbal exercises)

UNIT IV	ENTREPRENEURSHIP SKILLS	9

Introduction to entrepreneurship; developing leadership qualities and team work; goal setting and real life scenarios; fundamentals of entrepreneurial skills – marketing strategies microcosmic and macrocosmic levels of product sales and survey – sector / industry appraisal and appreciation (review and understanding state of the nation / economy / environment / sector reports published) interaction and understanding the role of multilateral financial / institutional / industrial agencies such as World Bank, ADB, UNDP, CII.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Take international examination such as IELTS and TOEFL	2
CO2	Make presentations and participate in Group Discussions.	3
CO3	Successfully answer questions in interviews	3

TEXTBOOKS:	
1.	Business English Certificate Materials, Cambridge University Press.
2.	Graded Examinations in Spoken English and Spoken English for Work downloadable materials from Trinity College, London.
REFERENCES:	
1.	International English Language Testing System Practice Tests, Cambridge University Press
2.	Interactive Multimedia Programs on Managing Time and Stress.
3.	Personality Development (CD ROM), Times Multimedia, Mumbai.
E-RESOURCES:	
1.	http://www.slideshare.net/rohitjsh/presentationon group discussion
2.	http://www.washington.edu/doit/TeamN/present_tips.html
3.	http://www.oxforddictionaries.com/words/writingjobapplications
4.	http://www.kent.ac.uk/careers/cv/coveringletters.html

COURSE ARTICULATION MATRIX:

COs	**POs**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1.										3		
2.										3		
3.										3		
4.										3		
5.										3		

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

SEMESTER VII

ME 22701	ENGINEERING ETHICS AND HUMAN VALUES (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To enable the students to create an awareness of Engineering Ethics.
2.	To impart knowledge of a variety of moral issues, inquiries, dilemmas, and different moral and ethical theories.
3	To instill Moral and Social Values and Loyalty.
4	To create awareness on assessment of safety and risk
5.	To create an awareness of Engineering Ethics and Human Values.

UNIT I	INTRODUCTION TO ETHICS	9

Basic Concepts, Governing Ethics, Personal & Professional Ethics, Ethical Dilemmas, Life Skills, Emotional Intelligence, Thoughts of Ethics, Value Education, Dimensions of Ethics, Profession and professionalism, Professional Associations, Professional Risks, Professional Accountabilities, Professional Success, Ethics and Profession.

UNIT II	ENGINEERING ETHICS	9

Senses of 'Engineering Ethics' - variety of moral issues - types of inquiry - moral dilemmas – moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy – Models of Professional Roles - theories about right action - Self-interest - customs and religion - uses of ethical theories. Valuing Time – Co-operation – Commitment.

UNIT III	ENGINEER'S SOCIAL EXPERIMENTATION	9

Engineer's As Social Experimentation – Framing the problem –Determining the facts –Codes of Ethics – Clarifying Concepts –Application issues –Common Ground -General Principles –Utilitarian thinking respect for persons- Case study-The Challenger, Disaster of Tettron Dam

UNIT IV	ENGINEERS RESPONSIBILITY FOR SAFETY AND RISK	9

Safety and risk –Assessment of safety and risk –Risk benefit analysis and reducing risk- Safety and the EngineerDesigning for the safety-Intellectual Property rights (IPR)-Case Study - Bhopal Gas Tragedy, T*unnel* collapsed on the Jammu-Srinagar, North Chennai Oil Spill..

UNIT V	HUMAN VALUES	9

Morals, Values and Ethics-Integrity-Work Ethic-Service learning – Civic Virtue – Respect or others – Living Peacefully –Caring –Sharing –Honesty - Courage-Cooperation–Commitment – Empathy –Self Confidence Character –Spirituality-Case Study- Honesty in Sales, Morals in Work.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Identify and analyze an ethical issue in the subject matter under investigation or in a relevant field.	2
CO2	impart knowledge of various moral issues, inquiry, dilemmas, and moral and Ethical theories.	3
CO3	Assess their own ethical values and the social context of problems	3

CO4	Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human	3
CO5	To create an awareness on Human Values.	3

TEXTBOOKS:	
1.	1.Mike W.Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi,2017
2.	2.M. Govindarajan, S. Natarajan, V.S. Senthil Kumar "Engineering Ethics includes Human Values PHI Learning Pvt. Ltd-2009 -
REFERENCES:	
1.	Harris, Pritchard and Rabins "Engineering Ethics", CENGAGE Learning, India Edition, 2009.
2.	Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility" McGraw Hill Education, India Pvt. Ltd., New Delhi 2013.
3.	Prof.D.R. Kiran, "Professional Ethics and Human Values", McGraw Hill Education, India Pvt. Ltd., New Delhi 2007.
4.	Premvir Kapoor, "Professional Ethics and Human Values", Khanna Publishing House,2018.
5.	Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010
E-RESOURCES:	
1.	https://onlinecourses.nptel.ac.in/noc24_mg17/preview
2.	www.onlineethics.org
3.	www.nspe.org
4.	www.globalethics.org

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1.	2							3					2	
2.		1						3		2			2	
3.						3		3					2	
4.								3	1	2			2	
5.						2	3	3	2				2	

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

MN22701	AI AND ML FOR AUTOMATION (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	Understand the foundational concepts of artificial intelligence (AI) and machine learning (ML) techniques and apply them to automate industrial tasks.
2.	Develop and implement AI-based solutions for automation challenges in real world.
3.	Evaluate the ethical implications of AI and ML in automation and propose responsible solutions.

UNIT I	AI TECHNIQUES	9

AI and ML concepts, Overview of automation systems using AI and ML, Heuristic search techniques – Hill climbing, Best-First search, Fuzzy logic and fuzzy control systems, Genetic algorithm and Genetic programming

UNIT II	SUPERVISED LEARNING	9

Introduction to ML, Linear regression, Decision trees, Naïve Bayes classification, K-NN, Logistic regression, Ensemble methods.

UNIT III	UNSUPERIVSED LEARNING	9

Clustering algorithm – K-means, Hierarchical clustering, Dimensionality reduction and feature extraction techniques – PCA, LDA.

UNIT IV	DEEP LEARNING	9

Neural networks, Multi-layer perceptron, Convolutional Neural Networks, Recurrent Neural Networks

UNIT V	CASE STUDIES AND ETHICAL CONSIDERATIONS	9

Challenges faced during implementation, improvements achieved and lessons learned in implementation of predictive maintenance in a manufacturing plant, Optimization of supply chain processes in an industrial setting - Ethical implications of AI and ML in industrial automation - Bias and fairness in AI algorithms - Societal impacts - Responsible deployment of AI systems in industry

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Apply search techniques, rule-based techniques and algorithms for optimization in industries	2
CO2	Apply different learning techniques for analyze and classify data to facilitate decision making process.	3
CO3	Implement deep learning algorithms to solve complex problems in industrial automation, including image recognition, bottle neck identification, supply chain optimization.	3
CO4	Analyze case studies of AI and ML to identify challenges, improvements, and lessons learned in industrial automation, including predictive maintenance in manufacturing plants and optimization of supply chain processes,	4
CO5	Evaluate the ethical implications of AI and ML in industrial automation and	4

	propose strategies to address ethical concerns and ensure responsible use of AI technologies	

TEXTBOOKS:

1.	Micheal Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, 3rd Edition, Addision Wesley, England, 2011
2.	Timothy J Ross, "Fuzzy Logic with Engineering Applications", 4th Edition, Chichester, 2011, Sussex Wiley
3.	R. A. Collacott, "Mechanical Fault Diagnosis and condition monitoring", Chapman and Hall London A Halstead Press Book John Wiley & Sons, New York

REFERENCES:

1.	S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Fourth Edition, 2021
2.	Artificial Intelligence for Robotics, by Francis X. Govers, Packt Publishing Limited; Standard Edition (30 August 2018), ISBN-10 : 1788835441
3.	Simon Haykin, "Neural Networks and Learning Machines: A Comprehensive Foundation", Third Edition, Pearson, delhi 2016
4.	Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.

E-RESOURCES:

1.	Introduction to Machine Learning, https://nptel.ac.in/courses/106106139/
2.	An Introduction to Artificial Intelligence, https://nptel.ac.in/courses/106102220/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3				3	3						3		3
2	3				3	3						3		3
3	3	2			3	3						3		3
4	3	2			3	3						3		3
5	3					3		2				3		3

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

MN22709	DATA SCIENCE FOR AUTOMATION: THEORY AND PRACTICES (Common to ME and MN)	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

1.	To develop skills in data collection, preprocessing, analysis, and visualization for industrial datasets.
2.	To apply data science methodologies to solve practical problems in industrial automation.
3.	To explore advanced topics such as machine learning and predictive analytics in the context of industrial applications.

UNIT I	INTRODUCTION	8

Significance - data preprocessing techniques: data cleaning, transformation, and normalization - Statistical analysis - principles of data visualization - Exploratory Data Analysis (EDA) techniques - scatter plots – histograms - box plots.

UNIT II	STATISTICS	10

Sampling distributions – Test based on Normal, t-distribution, chi-square, and F-distributions – Analysis of variance - Completely Randomized Design – Randomized Block Design – Latin Square Design – 2 Factorial Design.

UNIT III	PREDICTIVE ANALYTICS	12

Forecasting - decision-making - Time series analysis: ARIMA and Exponential Smoothing - Regression analysis: Linear regression, polynomial regression, logistic regression - Classification algorithms: Decision trees, random forests, support vector machines (SVM), k-nearest neighbors (k-NN) - Clustering algorithms: K-means clustering, hierarchical clustering.

LABORATORY COMPONENT

LIST OF EXPERIMENTS

1.	Perform One-sample Z-test, one- and two-sample t-tests, paired t-test using Python/Minitab
2.	Perform the Correlation and covariance test using Python/Minitab
3.	Perform the Chi square goodness of fit using Python/Minitab
4.	Conduct the ANOVA and develop a linear model using Python/Minitab
5.	Create Histogram, Scatterplot and box plot using Python/Minitab
6.	Forecast the data with the linear models using Python/Minitab
7.	Forecast the data with the nonlinear regression model using Python/Minitab
8.	Design of decision tree using Python/Minitab
9.	Support Vector Machines (SVM) using Python/Minitab
10.	Cluster analysis using Python/Minitab

TOTAL: 60 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Understand the basics of data analytics using concepts of statistics and probability	2
CO2	Apply various inferential statistical analysis techniques to describe data sets and	3

	withdraw useful conclusions from acquired data set	
CO3	Develop a machine learning model to predict equipment failures based on historical data.	3
CO4	Apply data science concept and methods to solve problems in real world context.	3
CO5	Select advanced techniques to conduct thorough and insightful analysis and interpret the results.	4

TEXTBOOKS:

1.	Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani, "An Introduction to Statistical Learning: with Applications in R", Springer Publications, Second Edition, 2017.
2.	Gupta, S.C and Kapoor, V.K., "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, New Delhi, 2017.

REFERENCES:

1.	Middleton, J. A. "Experimental Statistics and Data Analysis for Mechanical and Aerospace Engineers" Chapman and Hall/CRC, 2021.
2.	Kumar, Zindani, Davim, "Artificial Intelligence in Mechanical and Industrial Engineering", CRC Press, 2021.
3.	Zsolt Nagy, "Artificial Intelligence and Machine Learning Fundamentals", Packt Publishing, 2018, ISBN: 978-1-78980-165-1

E-RESOURCES:

1.	https://onlinecourses.nptel.ac.in/noc21_cs69/preview
2.	https://www.statlearning.com/

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1.	3	2	2									2	1	1
2.	3	2	1									2	1	1
3.	3	2	1									2	1	1
4.	3	2	3		3							3	2	2
5.	3	2	3		3							3	2	2

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

MN22711	COMPREHENSION	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

1.	To recall the knowledge, acquired through various theory and laboratory courses studied from the first semester to the sixth semester.

METHOD OF EVALUATION

1.	The students will be assessed 100% internally to test his / her understanding of fundamental concepts of mechanical and automation engineering discipline.
2.	Seminars, MCQ-type tests, case studies, etc. will be conducted at periodical intervals by covering all the professional core courses.

TOTAL: 15 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	understand and comprehend any given problem related to mechanical engineering field.	2

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1.	3	3	2		2							2	2	

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

MN22712	INDUSTRIAL TRAINING/INTERNSHIP	L	T	P	C
		0	0	0	2

COURSE OBJECTIVES:

1.	Apply academic knowledge to real-world scenarios, fostering practical skills in problem-solving and experimentation.
2.	Develop professional competencies like communication, teamwork, and problem-solving through hands-on industry experience.

COURSE DESCRIPTION

1.	The students should undergo Industrial training / Internship for a period of 2 to 4 weeks during summer / winter vacation and should earn a minimum of 1 credit or a maximum of 2 credits.
2.	The Internship / Industrial training to be completed between 4th to 6th semester 3. The students may undergo Internship at Research organization / University (after due approval from the Department Consultative Committee) for a period prescribed in the curriculum during summer / winter vacation, in lieu of Industrial training.

TOTAL: 15 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Apply academic theory to industrial challenges effectively.	3
CO2	Demonstrate improved communication and collaboration skills.	3
CO3	Develop professionalism and adaptability in the workplace.	3

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1.									3	3		1	1	
2.									3	3		1	1	
3.									3	3		1	1	

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

SEMESTER VIII

MN22811	PROJECT WORK	L	T	P	C
		0	0	20	10

COURSE OBJECTIVES:

1.	To develop the ability to solve a specific problem right from its identification and literature Review till the successful solution of the same.
2.	To train the students in preparing project reports and to face reviews and viva voce examination.

METHOD OF EVALUATION

1.	The students in a group of 3 to 4 work on a topic approved by the Head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by an external and internal examiner constituted by the Head of the Department.

TOTAL: 300 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Students will be able to demonstrate their understanding by effectively applying proper methodology to summarize and solve challenging practical problems.	5

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1.									3	3		1	1	

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

VERTICAL 2
PRODUCT AND PROCESS DEVELOPMENT

ME22021	DESIGN FOR MANUFACTURING ASSEMBLY AND ENVIRONMENT (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To Provide students with a comprehensive understanding of the design process in engineering, emphasizing principles that enhance manufacturability and cost-effectiveness
2.	To Equip students with the knowledge and skills necessary for effective design in various metal manufacturing processes, including casting, welding, and forging.
3.	To Teach students with an in-depth understanding of various machining processes and the essential design principles to optimize components for machining.
4.	To Prepare students with the knowledge and skills to design components and systems for efficient manual assembly
5.	To Educate students on integrating environmental considerations into product design to promote sustainability

UNIT I	PHILOSOPHY AND MATERIAL SELECTION	9

Introduction: Design philosophy – steps in design process – general design rules for manufacturability – basic principles of designing for economical production – creativity in design, application of linear & non-linear optimization techniques. Materials: Selection of materials for design – developments in material technology – criteria for material selection – material selection interrelationship with process selection – process selection charts.

UNIT II	CASTING, WELDING AND FORMING	9

Metal Casting: selection of casting process - general design considerations for casting - casting tolerances - use of solidification simulation in casting design - product design rules for sand casting. Metal Joining: Factors in design of weldments - general design guidelines - pre and post treatment of welds - effects of thermal stresses in weld joints. Forging: Design factors for Forging - design principles for Punching, Blanking, Bending, Deep Drawing - Component Design for Blanking.

UNIT III	MACHINING PROCESS	9

Overview of various machining processes - general design rules for machining - Dimensional tolerance and surface roughness - Design for machining - Ease - Redesigning of components for machining ease with suitable examples. General design recommendations for machined parts

UNIT IV	ASSEMBLY	9

General design guidelines for manual assembly- assembly efficiency- classification system for manual handling- classification system for manual insertion and fastening- effect of part symmetry on handling time- effect of part thickness and size on handling time- effect of weight on handling time- parts requiring two hands for manipulation- effects of combinations of factors, estimation of insertion time.

UNIT V	ENVIRONMENT	9

Environmental objectives- Lifecycle assessment- Basic method- Environmentally responsible product assessment- Techniques to reduce environmental impact, Design to minimize material usage- Design for recyclability, Design for remanufacture- Design for energy efficiency- Design to regulations and standards

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	To Provide students with a comprehensive understanding of the design process in engineering, emphasizing principles that enhance manufacturability and cost-effectiveness.	3
CO2	To Equip students with the knowledge and skills necessary for effective design in various metal manufacturing processes, including casting, welding, and forging.	4
CO3	To Teach students with an in-depth understanding of various machining processes and the essential design principles to optimize components for machining.	3
CO4	To Prepare students with the knowledge and skills to design components and systems for efficient manual assembly.	4
CO5	To Educate students on integrating environmental considerations into product design to promote sustainability.	4

TEXTBOOKS:

1.	A K Chitale and R C Gupta, "Product Design and Manufacturing", PHI, New Delhi, 2003.
2.	Boothroyd G, "Product design for Manufacture and Assembly", First Edition, Marcel Dekker Inc, New York, 1994
3.	Kevien Otto and Kristin Wood, Product Design. Pearson Publication, 2004.
4.	K.T. Ulrich and S.D. Eppinger, Product design and development, Tata McGraw Hill, 2020
5.	Fixel, J. Design for the Environment McGraw Hill., 1996.
6.	Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub.1996.

REFERENCES:

1.	Dickson, John. R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 1995.
2.	Bralla, Design for Manufacture handbook, McGraw Hill, 1999.

E-RESOURCES:

1.	https://Onlinecourses.nptel.ac.in/noc19_me48/preview
2.	https://nptel.ac.in/courses/107103012

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3					1	1		1	1				
2	3	3				1	1		1	1				
3	3					1	1		1	1				
4	3	2				1	2		1	1				
5	3	3	3	1	1	1	2		1	1				

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

ME22022	FAILURE MODES AND EFFECTS ANALYSIS (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To understand the Failure Modes and Effects Analysis (FMEA) concepts and its types.
2.	To impart the knowledge in design FMEA process and steps involved in the implementation.
3.	To understand the methods of Process FMEA and control process.
4.	To familiarize the Risk assessment procedures based on the Risk Priority Number (RPN).

UNIT I	**INTRODUCTION**	9

Introduction to Failure Modes and Effects Analysis (FMEA) - Need of FMEA- Uses of FMEA-Types of FMEA- History of the tool.

UNIT II	**DESIGN FMEA**	9

Steps in Design FMEA-Identify the failure modes-potential effects of each failure mode and assign severity rating-Determine the potential causes-prevention controls and assign occurrence rating-detection controls and assign detection rating- Action Plans

UNIT III	**PROCESS FMEA**	9

PFMEA-Identify - process functions- Potential Failures – Effect of failure – Causes of failures – Process controls – Confirm the critical characteristics

UNIT IV	**RISK ASSESSMENT**	9

FMEA Risk Assessment strategy- Risk assessment methods- Risk Assessment Factors- Rating scale of Severity, Occurrence and Detection- Risk Priority Number (RPN) - Risk Matrix.

UNIT V	**CASE STUDY ON FMEA**	9

Case study- FMEA- Design FMEA - Process FMEA- Control plan.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Illustrate the failure mode effect analysis and its types.	2
CO2	Implement the design FMEA using the methods of design failure mode effect analysis.	3
CO3	Identify the various process FMEA modes and critical characteristics.	3
CO4	Calculate the risk assessment number to identify the risk factors in the process.	3
CO5	Model the FMEA in the real time industry applications by practice.	3

TEXTBOOKS:

1.	D. H. Stamatis , “Failure Mode and Effect Analysis: FMEA from Theory to Execution”, American society for quality, Second edition,2003
2.	Raymond J. Mikulak ,”The Basics of FMEA”, Productivity Press; 2nd edition,2008.

REFERENCES:

1. Gerardus Blokdyk, "FMEA failure modes effects analysis A Complete Guide", 5STARCooks, 2019.
2. Dean H. Stamatis, "Risk Management Using Failure Mode and Effect Analysis (FMEA)", ASQ Quality Press, 2019.
3. Mohammed Hamed, "Risk Assessment Using FMEA: A Case of Reliable Improvement", personal-lean, 2021.

E-RESOURCES:

1. https://nptel.ac.in/courses/112107241/
2. https://archive.nptel.ac.in/courses/110/101/110101010/
3. https://archive.nptel.ac.in/courses/110/105/110105094/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2	2										2	3	
2	2	3	3		3							2	3	
3	2	3	3		3							2	3	
4	2	3	3		3						2	2	3	
5	2	3	3		2						2	2	3	

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

ME22023	NEW PRODUCT DEVELOPMENT (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To impart the basic concepts of engineering design and product development with focus on the front-end processes
2.	To familiarize the product development processes and knowledge of concept generation and selection tools.

UNIT I	INTRODUCTION	9

Need for developing products – the importance of engineering design – types of design –the design process – relevance of product lifecycle issues in design –designing to codes and standards- societal considerations in engineering design –generic product development process – various phases of product development-planning for products –establishing markets- market segments- relevance of market research.

UNIT II	CUSTOMER NEEDS	9

Identifying customer needs –voice of customer –customer populations- hierarchy of human needs-need gathering methods – affinity diagrams – needs importance- establishing engineering characteristics-competitive benchmarking- quality function deployment- house of quality- product design specification-case studies

UNIT III	CREATIVE THINKING	9

Creative thinking –creativity and problem solving- creative thinking methods- generating design concepts-systematic methods for designing –functional decomposition – physical decomposition – functional representation –morphological methods-TRIZ- axiomatic design.

UNIT IV	DECISION MAKING AND PRODUCT ARCHITECTURE	9

Decision making –decision theory –utility theory –decision trees –concept evaluation methods–Pugh concept selection method- weighted decision matrix –analytic hierarchy process – introduction to embodiment design –product architecture – types of modular architecture – steps in developing product architecture.

UNIT V	DESIGN AND COST ANALYSIS	9

Industrial design – human factors design –user friendly design – design for serviceability – design for environment – prototyping and testing – cost evaluation –categories of cost – overhead costs – activity-based costing –methods of developing cost estimates – manufacturing cost –value analysis in costing.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand the role of engineering design in product development, emphasizing its significance in achieving functionality, efficiency, safety, and user satisfaction.	2
CO2	Identify and analyze customer needs by employing various methods such as interviews, surveys, observation, and focus groups.	3
CO3	Analyze the relationship between creativity and problem-solving, recognizing creativity as a fundamental aspect of generating innovative solutions to complex engineering challenges.	3

CO4	Identify different types of modular architecture, including functional, physical, and process modularization, and understand their applications in product design and development.	3
CO5	Evaluate the cost implications of design decisions and development activities, including manufacturing costs, overhead costs, and lifecycle costs.	3

TEXTBOOKS:

1.	Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development ", 4th Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9.
2.	Kevin Otto, Kristin Wood, "Product Design– Techniques in Reverse Engineering and New Product Development", Indian Reprint 2015, Pearson Education, ISBN-9788177588217.

REFERENCES:

1.	Clive L. Dym, Patrick Little, "Engineering Design: A Project-based Introduction", 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7.
2.	George E. Dieter, Linda C. Schmidt, "Engineering Design", McGraw-Hill International Edition, 4th Edition, 2009, ISBN 978-007-127189-9.
3.	Yousef Haik, T. M. M. Shahin, "Engineering Design Process", 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141.

E-RESOURCES:

1.	https://nptel.ac.in/courses/112107217/
2.	https://nptel.ac.in/courses/112104230/

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2		2									2	2	
2	2	2	2			3		1				2	2	
3	3	3	3	3			2	1				2	2	
4	3	3	3	3				1				2	2	
5	3	3	3	2			2					2	2	

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

ME22024	PRODUCT LIFE CYCLE MANAGEMENT (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	Familiarize with various strategies of Product Life cycle Management (PLM)
2.	To understand functions and features of PLM/PDM
3.	To understand different modules offered in commercial PLM/PDM tools
4.	To demonstrate PLM/PDM approaches for industrial applications
5.	To Use PLM/PDM with legacy data bases, CAX & ERP systems

UNIT I INTRODUCTION TO PLM AND PDM 9

Introduction to Product Life cycle Management (PLM), Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (CPDM), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM). PLM/PDM Infrastructure – Network and Communications, Data Management, Heterogeneous data sources and applications.

UNIT II PLM/PDM FUNCTIONS AND FEATURES 9

User Functions – Data Vault and Document Management, Workflow and Process Management, Product Structure Management, Product Classification and Programme Management. Utility Functions – Communication and Notification, data transport, data translation, image services, system administration and application integration.

UNIT III MODULES IN APDM/PLM SOFTWARE 9

Case studies based on top few commercial PLM/PDM tools.

UNIT IV PLM ROLE IN ININDUSTRIES 9

Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for– business, organization, users, product or service, process performance.

UNIT V BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE 9

PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Summarize the various strategies of PLM.	2
CO2	Use the functions and features of PLM/PDM.	2
CO3	Use different modules offered in commercial PLM/PDM tools.	2
CO4	Implement PLM/PDM approaches for industrial applications.	3
CO5	Integrate PLM/PDM with legacy data bases, CAX & ERP systems.	3

TEXTBOOKS:

1.	Antti Saaksvuori and Anselmi Immonen, “Product Lifecycle Management”, Springer Publisher, 2008 (3rd Edition).
2.	Michael Grieves, “Product Life Cycle Management”, Tata McGraw Hill, 2006.
3.	Karl Ulrich, Steven Eppinger, “Product Design and Development”, McGraw-Hill Education, 2012
4.	Burden, Rodger PDM: Product Data Management, Resource Publications, 2003
5.	Saaksvuori, Antti & Immonen, Anselmi. Product Lifecycle Management, Springer-Verlag, 2004
6.	Gerardus Blokdyk, “PLM Software A Complete Guide”, 2019
7.	Stark, John. “Product Lifecycle Management: Paradigm for 21st Century Product Realization”, Springer-Verlag, 2011.

REFERENCES:

1.	International Journal of Product Lifecycle Management, Inderscience Publishers
2.	Ivica Crnkovic, Ulf Asklund and Annita Persson Dahlqvist, “Implementing and Integrating Product Data Management and Software Configuration Management”, Artech House Publishers, 2003
3.	Michael Grieves, “Product Life Cycle Management”, Tata McGraw Hill 2006.

E-RESOURCES:

1.	https://archive.nptel.ac.in/courses/112/107/112107217/
2.	https://archive.nptel.ac.in/noc/courses/noc18/SEM1/noc18-me31/
3.	Product Lifecycle Management for a Global Market, Springer; 2014 edition (29 September 2016), ISBN-10 : 3662516330.
4.	Product Life Cycles and Product Management, Praeger Publishers Inc (27 March 1989)ISBN-10 : 0899303196.

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	2		1							1	2	
2	3	2	2		1					1		1	2	
3	3	1	2		1					1		1	2	
4	3	1	2		1					1		1	2	
5	3	1	2		1					1		1	2	

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

ME22025	QUALITY AND FINANCIAL CONCEPTS IN PRODUCT DEVELOPMENT (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To provide knowledge on quality tools such as seven old and new tools of quality, statistical process control, multivariate charts, box plots, Pareto charts in product development.
2.	To impart benchmarking quality function deployment, house of quality and reliability in product development.
3.	To use Six Sigma and Lean manufacturing concepts in product development
4.	To apply Robust and embodiment design in product development.
5.	To understand Finance and working capital management in product development

UNIT I	STATISTICAL TOOLS FOR PROCESS QUALITY	9

Seven statistical tools of quality – new seven management tools – multivariable charts and 3d plot – statistical process control (SPC): problems in mean and range chart; p, np, u and c chart; problems in box plot and pareto chart.

UNIT II	QUALITY TOOLS FOR FUNCTION AND FAILURES	

Benchmarking: Types; Process; Benefits – quality function deployment (QFD): Concept; Benefits; Process; house of quality (HoQ): structure and methodology – reliability: hazard / failure rate; mean time between failure; simple problems in series; parallel; combination; standby systems**9**

UNIT III	DESIGN FOR QUALITY PRINCIPLES	9

Six Sigma: definition; concept; process Define, Measure, Analyze, Improve and Control (DMAIC Methodology) – project selection for six sigma (types of quality problems) – key tools in lean production / manufacturing – 4R total improvement – PDSA cycle: phases; benefits – Kaizen and Kairyo – 5S housekeeping – Total Productive Maintenance (TPM): definition; objective; pillars; steps.

UNIT IV	ROBUST DESIGN AND EMBODIMENT DESIGN	9

Robust design: definition; process steps – embodiment design: basic methods: refining geometry and layout - Failure Mode and Effects Analysis (FMEA) procedure; benefits.

UNIT V	FINANCE AND WORKING CAPITAL MANAGEMENT	9

Financial planning: definition; need; sources; capital structure; capitalization; term loans; Short term Finance; venture capital; export finance – working capital management: definition; significance; assessment; factors; sources; management.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Apply** the concept and principles of quality tools such as seven old and new tools of quality, statistical process control, multivariate charts, box plots, pareto charts in product development.	3
CO2	**Practice** the quality tools such as benchmarking, quality function deployment, house of quality, and reliability in product development.	3
CO3	**Apply** the six sigma and lean manufacturing concepts in productdevelopment.	3

CO4	**Execute** robust design and embodiment design in product development.	3
CO5	**Accomplish** finance and working capital management in product development.	3

TEXTBOOKS:

1.	Baker, M. & Hart S. "Product Strategy and Management." (2nd. Ed.) Edinburgh: Pearson education, 2007.
2.	Hitoshi Kume, "Quality Management in New Product Development" 1st edition, Productivity Press, 2008.
3.	Ulrich, K. & Eppinger, S., "Product Design and Development." (5th. Ed.) Los Angeles: McGraw Hill Education, 2012.

REFERENCES:

1.	Amitava Mitra, "Fundamentals of Quality Control and Improvement", 2nd edition, , Pearson Education Asia, 2002
2.	Kevin Otto & Kristin Wood, 'Product Design Techniques in Reverse Engineering and New Product Development," Pearson Education (LPE), 2001
3.	James R. Evens, William M Lindsay," The Management and Control of Quality,"6th edition, Published by Son South-Western University of Mumbai,2014.

E-RESOURCES:

1.	https://archive.nptel.ac.in/courses/112/107/112107217/
2.	https://elearn.nptel.ac.in/shop/nptel/total-quality-management-i/
3.	http://www.digimat.in/nptel/courses/video/112107217/L11.html
4.	https://www.classcentral.com/course/swayam-new-product-development-14210
5.	https://www.coursehero.com/file/137188593/Product-Development-Notesdocx/

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2	2	1									1	2	
2	3	2	1									1	2	
3	2	2	1									1	2	
4	2	2	1									1	2	
5	2	1	1								3	1	2	

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

ME22026	SYSTEM DESIGN FOR SUSTAINABILITY (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To familiarize the sustainability, need and its development.
2.	To understand the sustainability design for product service systems with strategies and guidelines towards the environmental, social and distributed economies systems.
3.	To explain the methods for system sustainability and its stages and tools for system design for sustainability.
4.	To practice the various tools for analyzing the system design for sustainability

UNIT I	INTRODUCTION- BASICS OF SUSTAINABILITY	8

Sustainability, historical perception -need of sustainable development – recognized role for design- evolution of sustainability design- sustainability dimensions -design for sustainability

UNIT II	SUSTAINBILTY DESIGN FOR PRODUCT LIFE CYCLE	8

Introduction to Product Life cycle Management (PLM), need for PLM– product life cycle- Principles of Life cycle assessment (LCA)- life cycle assessment- concept of eco- costs- Classical Life cycle assessment (CLCA)- Fast track Life cycle assessment (FLCA)- life cycle assessment paradigm- system boundary.

UNIT III	DESIGN FOR SUSTAINABLE PRODUCT SERVICE SYSTEM	10

Definition, Types - sustainable product service – win-win opportunities- strategies and guidelines of product service system to environmental - social- distributed economies sustainabilities.

UNIT IV	SYSTEM DESIGN FOR SUSTAINABILITY	10

Objective of methods for system design for sustainability- stages for sustainability-oriented processes- tools- sustainability design orienting scenarios (SDOS) on sustainable product service system (SPSS) and Distributed economies (DE)- concept description form for sustainable product service system - stakeholders interaction storyboard- satisfaction offering diagram.

UNIT V	ANALYSIS OF SYSTEM DESIGN FOR SUSTAINABILITY	9

Strategic analysis toolkit (SAT) for distributed economies and socio-economic ecosystems (SEE) - distributed manufacturing (DM) applied to product service system - design toolkit**.**

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand design's crucial role in advancing the sustainability.	3
CO2	Analyze the given product’s life cycle using life cycle assessment methods	3
CO3	Apply the design concepts for Sustainable Product Service System	3
CO4	Execute the methods for system design for sustainability processes.	4
CO5	Analyze the socio-economic ecosystems applied to Product service system.	4

TEXTBOOKS:	
1.	Fabio Giudice, Guido La Rosa, "Product Design for the environment-A life cycle approach," Taylor & Francis, 2006.
2.	Kalpakjian,S and Schmid, S "Manufacturing Processes for Engineering Materials," 6th edition, Pearson, 2016.
3.	Seliger,G, Marwan, M.K. Khraisheh, I.S. Jawahir, D. Rodick, "Advances in Sustainable Manufacturing", IRP, Springer publishers, 2011.
REFERENCES:	
1.	Carlo vezzoli, luca Macrì Berill Takacs Dongfang Yang," System Design for Sustainability in Practice," Maggioli Editore, , Via del Carpin , 2022.
2.	Ceschin Fabrizio," Design for sustainability: A Multi-level Framework from Products to Socio-technical Systems (Routledge Focus on Environment and Sustainability**),**" 1st edition, Routledge,2021.
3.	Vezzoli,C, Brenda Garcia Parra,and Kohtala ,C, " Designing Sustainability for All: The Design of Sustainable Product-Service Systems Applied to Distributed Economies," 1st edition, Springer; 2021.
4.	Vezzoli, C., Kohtala, C., Srinivasan, A., Xin, L., Fusakul, M., Sateesh, D. and Diehl, J.C, "Product-service system design for sustainability. 1st edition, Routledge,2014.
E-RESOURCES:	
1.	http://www.lens-india.org,
2.	https://www.coursera.org/courses?query=sustainability
3.	https://www.youtube.com/playlist?list=PLwdnzlV3ogoXD4NBvgyZJhsDUgaEB1nV3
4.	https://www.youtube.com/user/CESEduPackTutorials.
5.	https://www.coursehero.com/file/137188593/Product-Development-Notesdocx/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2				2	2					1	1	
2	3	2				2	2					1	1	
3	3	1				2	2					1	1	
4	3	2				2	2					1	1	
5	3	2				2	2					1	1	

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

ME22027	VALUE ENGINEERING AND PROCESS PLANNING (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To Study the value of the engineering process and identify its functions within the process.
2.	To Determine appropriate value engineering methodologies for given projects and propose relevant training approaches
3.	To equip students with the necessary knowledge and skills to effectively utilize worksheets and guidelines for value engineering projects
4.	To Understand the principles of process planning and its significance in manufacturing.
5.	To Learn how to select appropriate production processes, tools, and parameters.
6.	To Estimate costs associated with different manufacturing operations.

UNIT I	VALUE ENGINEERING JOB PLAN AND PROCESS	9

Definition of value engineering and value analysis, Value management vs. traditional cost reduction techniques, Types of value functions, Creativity in value engineering. Job Plan and Process - Seven phases of the job plan, FAST Diagramming as a value engineering tool, Behavioral and organizational aspects, Principles of value analysis, Benefits of value engineering.

UNIT II	VALUE ENGINEERING TECHNIQUES	9

Creativity techniques (brainstorming, Gordon technique), ABC Analysis, Probabilistic approach, Make or buy decisions, Function cost-worth analysis (FCWA), Function Analysis System Technique (FAST), Break-even analysis, Life cycle cost (LCC)

UNIT III	WORKSHEETS AND GUIDELINES	9

Preparation of worksheets, Function classification, relationship, and summary, Cost analysis, Idea listing and comparison, Feasibility ranking, Value engineering proposal writing, financial aspects - Case studies and discussion.

UNIT IV	PROCESS PLANNING AND ACTIVITIES	9

Process Planning - Meaning and significance of process planning - Methods of process planning - Drawing interpretation - Material evaluation - Steps in process selection - Production equipment and tooling selection. Calculation for various production processes, Selection of jigs and fixtures, Quality assurance methods, Set of documents for process planning, Economics of process planning - Case studies.

UNIT V	PRODUCTION COST ESTIMATION	9

Methods of costing - Elements of cost estimation - Types of estimates - Estimating labor cost, material cost, and overhead charges. Estimation of Different Types of Jobs.

Importance of machine time calculation - Calculation of machining time for different lathe operations - Drilling and boring time estimation

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Possess a comprehensive understanding of value engineering and value analysis, distinguishing between the approaches and recognizing their significance in	3

	optimizing value within engineering projects.	
CO2	Apply the tools effectively to evaluate options, optimize value, and make informed decisions across various engineering contexts	3
CO3	Create and utilize the worksheets and guidelines for value engineering proposal/projects.	3
CO4	Develop effective process plans for various manufacturing operations and to estimate production costs accurately.	3
CO5	Calculate costs associated with various manufacturing operations	3

TEXTBOOKS:

1.	Mukhophadhyaya A K, Value Engineering, Sage Publications Pvt. Ltd., New Delhi, 2019
2.	Richard J Park, Value Engineering – A Plan for Inventions, St. Lucie Press, London, 2017.
3.	Sinha, B.P., Mechanical Estimating and Costing, Tata McGraw-Hill, Publishing Co., 1995.
4.	Ostwalal, P.F. and JairoMunez, Manufacturing Processes and Systems‖, 9th Edition, JohnWiley, 2008.

REFERENCES:

1.	Larry W Zimmesman. P E, Value Engineering –A Practical Approach for Owners Designers and Contractors, CBS Publishers, New Delhi, 1992
2.	Arthus E Mudge, Value Engineering, McGraw Hill Inc., New York, 1996
3.	Russell, R.S. and Tailor, B.W., Operations Management, 4th Edition, PHI, 2011.
4.	Chitale, A.V. and Gupta, R.C., Product Design and Manufacturing, 2nd Edition, PHI, 2011.

E-RESOURCES:

1.	https://onlinecourses.nptel.ac.in/noc19_me51/preview
2.	https://archive.nptel.ac.in/courses/110/105/110105155/
3.	https://archive.nptel.ac.in/courses/105/106/105106149/
4.	https://onlinecourses.nptel.ac.in/noc20_me12/preview

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	1	1		1		1					1	1	
2	3	1	1		1		1					1	1	
3	3	1	1		1		1					1	1	
4	3	1	1		1		1					1	1	
5	3	1	1		1		1				3	1	1	

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

ME22020	PRODUCT LIFE CYCLE MANAGEMENT LABORATORY (Common to ME and MN)	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

1.	Acquire prerequisite knowledge essential for effective PLM utilization
2.	Understand the procedural aspects of implementing PLM tools
3.	Develop confidence and competence in integrating CAD/CAE software with PLM systems

LIST OF EXPERIMENTS:

1.	Explore different CAD software tools and their basic features.
2.	Recreate engineering drawing sheet layouts using industry-standard practices.
3.	Create 3D models from 2D sketches using techniques like extrusion and revolution.
4.	Design, model, and assemble engineering components using solid modeling operations.
5.	Perform static structural analysis with FEA software.
6.	Conduct modal analysis for natural frequencies.
7.	Analyze thermal distribution and thermal stresses.
8.	Exhibiting use of following modules of any PLM software through at least six assignments • Organization • Workflow • Product Structure • Access Manager • Query Builder • Change Management • Schedule Manager • Manufacturing Process Planner

TOTAL: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Gain proficiency in exploring various CAD software tools, understand and apply their basic features within the context of PLM.	3
CO2	Demonstrate the ability to accurately recreate engineering drawing sheet layouts adhering to industry-standard practices using PLM software.	3
CO3	Develop skills in creating detailed 3D models from 2D sketches utilizing techniques such as extrusion and revolution within PLM environments.	4

REFERENCES:

1.	K.R. Gopalakrishnan," Machine Drawing", Pearson Education Publication, 2020
2.	Karl Ulrich, Steven Eppinger, "Product Design and Development", McGraw-Hill Education, 2012
3.	Burden, Rodger PDM: Product Data Management, Resource Publications, 2003
4.	Saaksvuori, Antti & Immonen, Anselmi. Product Lifecycle Management, Springer-Verlag, 2004
5.	Gerardus Blokdyk, "PLM Software A Complete Guide", 2019
6.	Stark, John. "Product Lifecycle Management: Paradigm for 21st Century Product Realization", Springer-Verlag, 2004. ISBN 1852338105

COURSE ARTICULATION MATRIX:														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1.	3	3			3				3				1	
2.	3	3	3		3				3					
3.	3	3	3		3				3				1	

SL.No.	**LIST OF EXPERIMENTS**	**Qty.**
1.	Computer Server	1
2.	Computer nodes or systems (High end CPU with atleast 1 GB main memory) networked to the server	30
3.	Laser Printer	1
4.	PLM Licensed software integrated with CAD and FEA	30
5.	Licensed operating system	30

VERTICAL 3
DIGITAL AND GREEN MANUFACTURING

ME22031	DIGITAL MANUFACTURING AND INTERNET OF THINGS (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	Acquire knowledge about the fundamentals of digital manufacturing.
2.	Understand the integration of IoT technologies with digital manufacturing processes.
3.	Apply data analytics techniques to interpret manufacturing data collected through IoT.

UNIT I	INTRODUCTION TO DIGITAL MANUFACTURING	9

Historical context and evolution of Digital Manufacturing - Key Components and Technologies - DNC and CNC - Additive Manufacturing - Adaptive control - types, application and benefits - general configuration of adaptive control and function – reasons for process change -practical problems with adaptive control - example for feedback and adaptive control.

UNIT II	MECHATRONIC ELEMENTS IN CNC MACHINE TOOLS	9

CNC systems - configuration of the CNC system – interfacing – monitoring – diagnostics machine data - compensations for machine accuracies - PLC in CNC – PLC programming for CNC, steps in programming and case studies - machine structure -types of loads on CNC machine - guide ways and types - mechanical transmission elements - elements for rotary motion to linear motion - ball screw and types -roller screw and types -rack and pinion - various torque transmission elements -requirements of feed drives and spindle drive.

UNIT III	INTERNET OF THINGS (IoT)	9

IoT Fundamentals and Architecture - Architecture and Layer - Types - IoT Systems - IoT devices - Sensors and Data Acquisition - Techniques - Challenges in industrial environments - Data Management and Security - Design and Methodology.

UNIT IV	COMMUNICATION PROTOCOLS	9

IoT Communication Protocols - Principles of Wired and Wireless Connectivity – Efficiency – Security – Range - Power consumption - Data rate - Scalability - Data Exchange in IoT systems - IoT Gateway - IoT Hardware - Cloud Computing - Fog and Edge Computing.

UNIT V	CHALLENGES AND CASE STUDIES	9

Security Threats and Vulnerabilities - Cyber threats in IoT-enabled manufacturing systems - Strategies for securing infrastructure, devices and data - Predictive Maintenance and Quality Control. Case studies -Connected Vehicles - Smart Grid - Industrial IoT - Agriculture, Healthcare, Activity Monitoring.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Apply procedural knowledge and technical skills to execute digital manufacturing processes.	3
CO2	Able to design and implement end-to-end IoT solutions.	3

CO3	Develop proficiency in collecting, processing, analyzing, and visualizing IoT data.	3
CO4	Gain an understanding of the security and privacy challenges inherent in IoT systems.	3
CO5	Apply IoT principles and technologies to real-world scenarios across different domains.	4

TEXTBOOKS:

1.	Groover, M.P., "Automation, Production System and CIM", Prentice Hall of India Pvt. Ltd, 2003.
2.	S. Misra, A. Mukherjee, and A. Roy, 2020. Introduction to IoT. Cambridge University Press.

REFERENCES:

1.	Kaushik Kumar, Divya Zindani , J. Paulo Davim, 2019. Digital Manufacturing and Assembly Systems in Industry 4.0 (Science, Technology, and Management), CRC Press.
2.	S. Misra, C. Roy, and A. Mukherjee, 2020. Introduction to Industrial Internet of Things and Industry 4.0. CRC Press.
3.	Internet of Things - A Hands on Approach - Arshdeep Bahga and Vijay Madisetti. Universities Press, ISBN: 9788173719547.
4.	Designing the Internet of Things - Adrian McEwen & Hakim Cassimality. Wiley India, ISBN: 9788126556861.

E-RESOURCES:

1.	https://onlinecourses.nptel.ac.in/noc22_cs53/preview

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2									1	2	
2	3	3	2		2							1	2	
3	3	3	2		2							1	2	
4	3	3	2		2							1	2	
5	3	3	3	3		2	1	1				1	2	

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

ME22032	SUSTAINABLE MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	Familiarize the concept and importance of sustainability manufacturing with tools and techniques
2.	To teach various tools/techniques of sustainable manufacturing
3.	Inculcate knowledge on performing life cycle analysis
4.	To impart the factors to be considered for Modelling a Green manufacturing environment
5.	Introduce the concept of green supply chain management

UNIT I	INTRODUCTION TO SUSTAINABLE MANUFACTURING	9

Introduction to Sustainable Manufacturing; Resources in manufacturing, Drivers of Sustainable Manufacturing; Concept of Triple bottom line; Environmental, Economic and Social Dimensions of Sustainability; Relation between Green, Lean and Sustainable manufacturing.

UNIT II	SUSTAINABLE MANUFACTUIRNG TOOLS	9

Environmental conscious- quality function deployment-R3 and R6 cycles-Environmental impact assessment methods- CML, EI 95 and 99, ISO 14001, EMS and PAS 2050 standards, environmental impact parameters. Sustainability assessment-concept models and various approaches, product sustainability and risk assessment-corporate social responsibility.

UNIT III	SUSTAINABLE PRODUCT DESIGN	9

Life cycle analysis-Remanufacture and disposal, tools for LCA, LCA assessment elements, optimization for achieving sustainability in manufacturing, value analysis, analysis for carbon footprint-software packages for sustainability analysis, factors effecting sustainability.

UNIT IV	GREEN MANUFACTURING MODELLING	9

Metrics for green manufacturing - Economic metrics, Environmental metrics, Societal metrics. Green manufacturing indicators - Product-level indicators for green manufacturing, Industry level indicators for green manufacturing, green manufacturing rating criteria, Number of indicators to use.

Developing Green Manufacturing System - Manufacturing strategy for green manufacturing, Steps in developing green manufacturing system, Identify the status Improvement plan, Implementation, Maintain Environment conservation activities

UNIT V	GREEN SUPPLY CHAIN	9

Carbon footprints in transportation, Green Supply chain: techniques and implementation Green Supply chain, Logistics management Green Supply Chain as Product Life Cycle Management, Case Studies: Green packaging and supply chain, implementation of lean manufacturing at industries.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Recognize the Need of Sustainable Manufacturing	2
CO2	Explore the State-of-art Tools & Techniques of Sustainable Manufacturing	3

CO3	Perform carbon footprint analysis and Life Cycle Assessment (LCA) specific to manufacturing systems and processes.	3
CO4	Design and develop green manufacturing and apply environmental norms	4
CO5	Develop Green Supply Chain Techniques.	4

TEXTBOOKS:

1.	Mrityunjay Singh, T. Ohji and Rajiv Asthana, "Green and Sustainable Manufacturing of Advanced Materials" Elsevier (1st Ed.) 2015.
2.	G. Seliger, Marwan, M.K. Khraisheh, I.S. Jawahir, D. Rodick, "Advances in Sustainable Manufacturing", IRP, Springer publishers, 2011

REFERENCES:

1.	Klemes J., Sustainability in the process industry. McGraw-Hill, 2011.
2.	G. Atkinson, S. Dietz, E. Neumayer, Handbook of Sustainable Manufacturing. Edward Elgar Publishing Limited,2007
3.	Christian N. Madu, Handbook of environmentally conscious manufacturing, London Kluwer Academic Publishers,2001.
4.	Joseph Sarkis, Greener manufacturing and operations: from design to delivery and back, Greenleaf Publications, 2001
5.	Balkan Cetinkaya and Richard Cuthbertson 'Sustainable Supply Chain Management' 2nd Edition, Springer, 2011.
6.	Rogers, P.P., Jalal, K.F. and Boyd, "An Introduction to Sustainable Development", Earth scan, London, 2007.
7.	D. Rodick, Industrial Development for the 21st Century: Sustainable Development Perspectives, New York, 2007
8.	U.S. Department of Energy, Office of the Energy efficiency and renewable energy, "Sustainable manufacturing and the Circular Economy, 2023

E-RESOURCES:

1.	https://nptel.ac.in/courses/112104225
2.	https://vrscet.digimat.in/nptel/courses/video/112104225/L21.html

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2						1			1				2
2	3						1			1				3
3	3	2					1			1				3
4	3	2					1			1				3
5	3						1			1				3

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

ME22033	ENVIRONMENTAL IMPACT ASSESSMENT (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	Emphasize the significance of conducting an Environmental Impact Assessment (EIA) as an integral part of the planning process for the proposed project.
2.	Identify and assess the anticipated environmental impacts of the project, considering various factors such as land use, air quality, water resources, biodiversity, and socio-economic aspects.
3.	Determine the key environmental parameters and attributes that will be monitored and assessed throughout the EIA process.

UNIT I	**INTRODUCTION TO EIA**	**9**

Concepts of environmental impact assessment: Environment; environmental impacts; environmental impact analysis; and environmental impact statement; EIA- as an integral part of the planning process

UNIT II	**DETAILED CONTENTS OF EIA**	**9**

Detailed Contents of EIA: Introduction; Project Description; Description of The Environment; Anticipated Environmental Impacts and Mitigation Measures: Analysis of Alternatives; Environmental Monitoring Programme; Additional studies; Project Benefits; Environmental Cost Benefit Analysis

UNIT III	**ENVIRONMENTAL ATTRIBUTES**	**9**

Environmental attributes: air; water; noise; land and soil. Description of the Baseline Environment: Purposes for defining the Environmental Setting; Selection of parameters, Monitoring of physical environmental parameters, Collection, and interpretation of baseline data for various environmental attributes

UNIT IV	**ASSESSMENT METHODS**	**9**

Prediction and Methods of Assessment of Impacts on Various aspects of Environment; Application of various models for the Prediction of impact on Air Environment, Water Environment, Noise Environment and Land

UNIT V	**PROJECT CATEGORIZATION AND CASE STUDIES**	**9**

Categorization of projects, Procedure for getting environmental clearance. Case studies on EIA for Industries and Infrastructure projects

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understands the importance of EIA as an integral part of planning process	2
CO2	Examine the project for anticipating the impact on environment and analysis of alternatives.	3
CO3	Examine different environmental attributes and selecting the environmental parameters affecting project	3
CO4	Apply various methods to Predict the Environmental impacts of project after deciding various environmental attributes	4

CO5	Create the EIA report for getting Environmental clearance	4

TEXTBOOKS:

1.	Anjaneyulu Yerramilli and Valli Manickam, Environmental Impact assessment methodologies, BS publications, 2000.
2.	John Glasson and Riki Therivel,Introduction To Environmental Impact Assessment 5th Edition, Taylor and francis, 2019.

REFERENCES:

1.	V. S. Kulkarni, Dr. S. N. Kaul and R. K. Trivedy, A Handbook of Environment Impact Assessment Hardcover Scientific publisher journals, 2002
2.	Rau Whooten, Environmental Impact Analysis Handbook, McGraw Hill publications, 1980
3.	Judith Petts, Handbook of Environment Impact Assessment, McGraw Hill publications, 1999

E-RESOURCES:

1.	https://onlinecourses.nptel.ac.in/noc23_ar04/preview

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1						2	3							2
2		2				2	3							2
3	2			3	2	2	3					2		2
4				2		2	3	3			2	2		2
5				2	1	2	3	2			2	2		2

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

ME22034	GREEN MANUFACTURING DESIGN AND PRACTICES (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To introduce the concept of environmental design and industrial ecology
2.	To impart knowledge about air pollution and its effects on the environment.
3.	To enlighten the students with knowledge about noise and its effects on the environment.
4.	To enlighten the students with knowledge about water pollution and its effects on the environment. To introduce the concept of green co-rating and its need.

UNIT I	DESIGN FOR ENVIRONMENT AND LIFE CYCLE ASSESSMENT	9

Introduction to Environmental effects of design -natural friendly material –application- Eco friendly design - Emission less manufacturing– Pollution prevention – Reduction of toxic emission – design for recycle.

UNIT II	POLLUTANTS AND MEASUREMENT	9

Pollutants-Types-Industrial Pollution- Ambient air quality Standards- Air pollution sampling-collection of gaseous air pollutants-collection of particulate pollutants-stock sampling- analysis of air pollutants-sulfur dioxide-nitrogen dioxide- carbon monoxide- oxidants and ozone.

UNIT III	NOISE POLLUTION AND CONTROL	9

Definition and types of noise pollution-Frequency and Sound Levels- Units of Noise based power radio-Measuring Instruments for frequency and Noise levels-types-Standards for acceptable noise levels in different environments- Noise mitigation strategies-Engineering Controls-Sound barriers-noise-reducing materials.

UNIT IV	WATER DEMAND AND WATER QUALITY	9

Water resources-importance of water demand and quality-Factors affecting consumption-Variation-Contaminants in water-Nitrates-Fluorides- Detergents- taste and odour- Radio activity in water- Major pollutants of Water- Water Quality Requirement for different uses-Global water crisis issues.

UNIT V	GREEN CO-RATING	9

Ecological Footprint - Need for Green Co-Rating – Green Co-Rating System – Intent – System Approach – Weightage- Assessment Process – Types of Rating – Green Co-Benefits – Case Studies Of Green Co-Rating

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand the environmental design and selection of eco-friendly materials	2
CO2	Examine manufacturing processes towards minimization or prevention of air pollution.	4
CO3	Analyse manufacturing processes towards minimization or prevention of noise pollution.	4
CO4	Analyse manufacturing processes towards minimization or prevention of water pollution.	4

CO5	Examine green co-rating and its benefits	4

TEXTBOOKS:

1.	D. Dornfeld (ed.), Green Manufacturing: Fundamentals and Applications, Springer, New York, 2013.
2.	Gradel.T.E. and B.R. Allenby, Industrial Ecology, Prentice Hall, 2010
3.	Rao M.N. and Dutta A.K. Wastewater treatment, Oxford & IBH publishing Co. Pvt. Ltd., New Delhi, Second Edition, 2006

REFERENCES:

1.	Frances Cairncross, Costing the Earth: The Challenge for Governments, the Opportunities for Business, Harvard Business School Press,1993.
2.	World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.
3.	Rao CS, Environmental Pollution Control Engineering, Wiley Eastern Ltd., New Delhi, 2006.
4.	Lewis H Bell and Douglas H Bell, Industrial noise control, Fundamentals and applications, Marcel Decker, 1994.

E-RESOURCES:

1.	https://archive.nptel.ac.in/courses/112/104/112104225/
2.	https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-mg24/

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2				1	1			1		1	1	
2	3	2				1	1			1		1	1	
3	3	2				1	1			1		1	1	
4	3	2				1	1			1		1	1	
5	3	2				1	1			1		1	1	

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

ME22035	GREEN SUPPLY CHAIN MANAGEMENT (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To introduce the concepts of green supply chain Management (GSCM) to the students
2.	To stress on importance of measuring and managing GSCM
3.	To incorporate knowledge of developing sustainable product for environment

UNIT I	**INTRODUCTION TO GREEN SUPPLY CHAIN MANAGEMENT**	**9**

Green supply Chains – Need for Green Supply Chains – Implications of modern supply chain management – The supply chain strategy – Sustainable Development Goals (SDG)- Environmental concerns of the modern society

UNIT II	**MEASURING AND MONITORING GREEN SUPPLY CHAINS**	**9**

Ingredients of green supply chain strategy -Evaluating the impact of GSCM activities on sustainability – Economic, Environmental, and social impacts of GSCM- Stages of GSCM - performance measurement.

UNIT III	**MANAGING SUPPLY NETWORK OF GREEN SUPPLY CHAIN**	**9**

Managing supply chain processes – Analyzing and monitoring systematically – Green Supply Chain Segmentation - Supply chain operations reference (SCOR) model – Green SCOR as a focused model; – Optimization of goods collection

UNIT IV	**LIFE CYCLE APPROACH AND SUSTAINABLE ECO-DESIGN**	**9**

Stages of product development process in green design: Materials- Manufacturing - Packaging and use - Estimating product life cycle- End of Life and disposal - Design for recycling - Life Cycle Assessment (LCA), and Eco-design tools - Environmental management systems, and International standards

UNIT V	**LOGISTICS & CASE STUDIES**	**9**

Challenges and issues – Transport marketplace – Transport exchange – GSCM enablers with I4.0 - Waste generated in supply chain processes- GSCM case studies.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand concept of Green supply chain management and Sustainability	2
CO2	Monitor Green Supply Chain Management.	3
CO3	Manage the supply network and address its issues	3
CO4	Analyze stages of creating sustainable ecofriendly product	3
CO5	Find solutions logistic problems in GSCM through case studies	3

TEXTBOOKS:

1.	Green Supply Chain Management, by Charisios Achillas , Dionysis D. Bochtis , Dimitrios Aidonis, Routledge; 1st edition, 2018

2.	Supply Chains - A Research-Based Textbook on Operations and Strategy by Yann Bouchery, Charles J. Corbett, Jan C. Fransoo and Tarkan Tan, Volume 4, Springer Series in Supply Chain Management,2017

REFERENCES:

1.	Balkan Cetinkaya and Richard Cuthbertson 'Sustainable Supply Chain Management' 2nd Edition, Springer, 2011
2.	Micheal Hugos, Essentials of Supply Chain Management, Wiley, 2018
3.	Sunil Chopra and Peter Meindl, Supply Chain Management, Pearson Publishers, 2016.

E-RESOURCES:

1.	https://nptel.ac.in/courses/110108056

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2	1					2							2
2		1					2				2			2
3				2			3							2
4			3	2		2	3	3						3
5		2	3				3			2				2

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

ME22036	LEAN MANUFACTURING (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	Understand the principles of lean manufacturing to identify and eliminate waste within production processes.
2.	Implement strategies such as Just in time (JIT) continuous improvement, Total productive maintenance (TPM) and value stream mapping to streamline operations and increase efficiency.
3.	Learn techniques like Total Quality Management (TQM) and mistake-proofing (Poka-Yoke) to ensure high-quality output.

UNIT I	INTRODUCTION	9

Introduction to Lean and Factory Simulation: History of Lean and comparison to other methods – The 8 Wastes, their causes and the effects – An overview of Lean Principles – Stock less Production.

UNIT II	LEAN TOOLS	9

The Tools of Lean Manufacturing: Continuous Flow – Continuous Flow Manufacturing and Standard Workflow – 5S and Pull Systems (Kanban and WIP systems) – Error Proofing and Set-up Reduction - SMED – Total Productive Maintenance (TPM) – Kaizen Event examples. Toyota production systems, Ford production systems

UNIT III	LEAN SYSTEM	9

Lean systems: Features manufacturing and services, Workflow, Small lot sizes, Pull Method, Kanban, Just In Time - Problems.

UNIT IV	PROJECT SELECTION FOR LEAN	9

Resource and project selection, Selecting projects, Process mapping, Current and future value stream mapping, project suitable for lean initiatives.

UNIT V	LEAN MANAGEMENT AND IMPLEMENTATION	9

Standardized work, continuous improvement. Lean projects - Case Study: Training, selecting the Members, preparing project plan, implementation, review. Productivity improvement: Process, machinery operator and equipment.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand the importance of Lean management in enhancing organizational efficiency, reducing waste, and improving overall performance.	2
CO2	Acquire proficiency in utilizing a variety of Lean tools and techniques, such as 5S, Kaizen, Kanban, and Visual Management, to streamline processes and drive continuous improvement.	3
CO3	Implement practices such as cross-training and multi-skilling to create a flexible workforce that can adapt to varying production requirements.	3
CO4	Enable to visualize, analyze, and optimize the production processes to create value for customers, eliminate waste, and achieve operational excellence.	3

CO5	Ensure the long-term viability and success of the organization by continuously improving processes and adapting to changing market conditions.	3

TEXTBOOKS:

1.	Gopalakrishnan N, Simplified Lean Manufacture: Elements, rules, tools and implementation, Prentice Hall of India, NewDelhi 2013.
2.	James P. Womack , Daniel T. Jones ,Lean Thinking, Free press business,2013.

REFERENCES:

1.	Kai Yang and Basemel-Haik, "Design for Six-Sigma: A Roadmap for Product Development", McGraw Hill, 2009.
2.	Michael L. George, David Rowlands, Bill Kastle, what is Lean Six Sigma, Tata McGrawHill,2003.
3.	James P. Womack, Daniel T. Jones, Lean Thinking, Free press business,2013.

E-RESOURCES:

1.	https://nptel.ac.in/courses/110107130

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3		2			2				1		2		2
2	2	1	3	2			2			1		2		2
3	2	1	3	2			2			1		2		3
4	2	1	3	1			2			1		2		3
5	2	1	3	1			2			1		2		3

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

ME22037	STATISTICAL AND QUALITY TECHNIQUES FOR MANUFACTURING (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	Understand the fundamental principles of statistical analysis and their application in manufacturing.
2.	Apply statistical process control techniques to monitor and control manufacturing processes.
3.	Design and conduct experiments to optimize manufacturing processes and improve product quality.
4.	Implement quality management principles to enhance overall manufacturing performance
5.	Apply Six Sigma methodology and lean concepts to reduce defects and wastage in manufacturing processes.

UNIT I	INTRODUCTION TO STATISTICAL METHODS IN MANUFACTURING	9

Concept of quality, quality characteristics, quality standards, quality cost, concept of quality control, quality control methodology, statistical methods of quality control, quality philosophy and management strategies. Statistical Description of Quality: Population and sample, techniques of sampling, simple random sample, analysis of sample data, representation of sample data, practical examples

UNIT II	STATISTICAL PROCESS CONTROL (SPC)	9

Introduction to SPC and its importance in manufacturing - Basis of control chart, types of control chart, design of control chart, analysis of control chart, control charts for variables and attributes, case studies. Process Capability: Concept of process capability, measures of process capability, potential process capability, actual process capability, process capability analysis, case studies.

UNIT III	DESIGN OF EXPERIMENTS (DOE) & SAMPLING SCHEMES	9

Introduction to experimental design principles-- Factorial designs and their applications - Response surface methodology-- Analysis of variance (ANOVA)- Experimental setup and data analysis techniques.

Basis of sampling schemes, types of sampling schemes, acceptance sampling schemes for variables and attributes.

UNIT IV	QUALITY MANAGEMENT PRINCIPLES (6 HOURS) **	9

Introduction to quality management systems (QMS) - Total Quality Management (TQM) principles - ISO 9000 standards and certification-- Quality tools and techniques: Pareto analysis, cause-and-effect diagrams, etc.- Case studies on quality management implementation- Six Sigma principles and DMAIC methodology

UNIT V	LEAN MANUFACTURING & CASE STUDIES ON SQC	9

Introduction to lean manufacturing principles- - Value stream mapping-- Just-In-Time (JIT) production - Kaizen and continuous improvement-- Practical applications and case studies--

Analysis of real-world manufacturing case studies-- Application of statistical and quality techniques to address manufacturing challenges

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand the fundamental principles of statistical analysis and their application in manufacturing.	2
CO2	Apply statistical process control techniques to monitor and control manufacturing processes.	3
CO3	Implement quality management principles to enhance overall manufacturing performance.	3
CO4	Utilize Six Sigma methodology to reduce defects and variation in manufacturing processes.	3
CO5	Identify and apply lean manufacturing concepts to eliminate waste and improve efficiency.	3

TEXTBOOKS:

1.	Montgomery, D. C. "Introduction to Statistical Quality Control", John Wiley & Sons, 2017
2.	Douglas, C. M., & Magrab, E. B. (2016). Engineering Statistics. John Wiley & Sons.

REFERENCES:

1.	Pyzdek, T., & Keller, P. A. (2014). The Six Sigma Handbook: A Complete Guide for Green Belts, Black Belts, and Managers at All Levels. McGraw-Hill Education.
2.	Womack, J. P., & Jones, D. T. (1996). Lean Thinking: Banish Waste and Create Wealth in Your Corporation. Simon and Schuster
3.	Total Quality Management: Dale H. Besterfield , Hemant Urdhwareshe , Mary Besterfield-Sacre , Carol Besterfield-Michna , Rashmi Urdhwareshe , Glen H. Besterfield, Pearson, ISBN: 978-81-7758-412-7
4.	Design of Experiment: Douglas C. Montgomery, John Wiley & Sons, ISBN: 0-471-31649-0

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	1	3												3
2	1	2		3										3
3	1	2		3										3
4	1	3		2										3
5	1	3		2										3

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

ME22030	DIGITAL MANUFACTURING AND IOT LABORATORY (Common to ME and MN)	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

1.	To accustom with the modern computer aided part programming.
2.	To familiarize with the key technologies and protocols used in IIoT deployments.
3.	To enable students to analyze and design IIoT solutions for real-world applications.

LIST OF EXPERIMENTS:

1.	Introduction to G and M codes for milling and turning
2.	Part Programming (Milling): Linear, circular interpolation and cutter radius compensation
3.	Part Programming (Milling): Canned cycle concept
4.	Part Programming (Turning): Straight, Taper and Radius Turning
5.	Part Programming (Turning): Thread cutting and tapping cycle
6.	Computer aided part programming
7.	Simulation of the light emitting diode
8.	Simulation of the light emitting diode with a push button
9.	Controlling the light emitting diode
10.	Temperature and Humidity measurement
11.	Detection System with Ultrasonic Sensor
12.	Data acquisition using the cloud database

TOTAL: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Enumerate the simulation results from the part programming (Milling)	3
CO2	Appraise the simulation results from the part programming (Lathe)	3
CO3	Understand the role of computer aided part programming.	4
CO4	Investigate the simulation results and interpret data generated by virtual IIoT devices.	4
CO5	Design and implement IIoT solutions for specific industrial applications, considering factors such as scalability and interoperability.	4

REFERENCES:

1.	Digital manufacturing and IOT Laboratory Manual Prepared by Faculty of Mechanical Engineering, Sri Venkateswara College of Engineering

E-RESOURCES:

1.	http://vlabs.iitkgp.ac.in/cim/#

COURSE ARTICULATION MATRIX:														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1.	3	2			3				2	2				2
2.	3	2			3				2	2				2
3.	3	1			3				2					3
4.	3	1			3				2					3
5.	3	1			3				2					2

SL.No.	**LIST OF EXPERIMENTS**	**Qty.**
1.	Desktop Computers	30 nos.
2.	CAM software	30 licenses
3.	IoT Kit	5 nos.

VERTICAL 4

LOGISTICS AND SUPPLY CHAIN MANAGEMENT

ME22041	BUSINESS ANALYTICS FOR MANAGEMENT DECISION (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	Understand the need for effective business analytics within an organization.
2.	Analyze complex problems using advanced analytics tools.
3.	Learn descriptive, predictive and prescriptive business analytics.
4.	Interpret data for better decision-making.
5.	Understand the need for effective business analytics within an organization.

UNIT I	INTRODUCTION TO BUSINESS ANALYTICS	9

Definition and importance of Business Analytics (BA) - Types of analytics: descriptive, predictive, Models in Business analytics, prescriptive- Role of business analytics in management decision-making - Overview of tools and techniques used in business analytics. Data types and sources - Data cleaning and pre-processing techniques.

UNIT II	DESCRIPTIVE ANALYTICS	9

Introduction to Descriptive analytics – Visualising, and Exploring Data - Descriptive Statistics - Sampling and Estimation - Probability Distribution for Descriptive analytics - Analysis of Descriptive analytics- Exploratory Data Analysis (EDA)- Data visualization techniques - Data manipulation tools like Excel, SQL, or Python libraries (e.g., Pandas)

UNIT III	PREDICTIVE ANALYTICS	9

Introduction to Predictive analytics- Logic and Data Driven Models - Predictive Analysis Modelling and procedure - Data Mining for Predictive analytics. Analysis of Predictive analytics -Time series Analysis and Regression Analysis-Case studies

UNIT IV	PRESCRIPTIVE ANALYTICS	9

Introduction to Prescriptive analytics - Prescriptive Modelling - Non-Linear Optimisation - Demonstrating Business Performance Improvement. Decision trees, Markov Decision Processes- Multi-Criteria Decision Analysis -Case Studies

UNIT V	DATA MINING AND BA APPLICATIONS IN MECHANICAL ENGINEERING	9

Overview of data mining concepts and Machine Learning (ML) algorithms, - Big Data analytics- Introduction to big data concepts and technologies. Applications of BA in predictive Maintenance, Supply Chain Optimization: Energy Efficiency, Product Life cycle Management (PLM)-Performance Monitoring and Optimization- cost optimization-Finance, Marketing, Human Resource Management, Supply Chain, Healthcare.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand the need for effective business analytics within an organization.	2
CO2	Analyze complex problems using Descriptive Analytics tools.	3
CO3	Analyze complex problems using predictive business analytics.	3
CO4	Analyze complex problems using Prescriptive business analytics.	3
CO5	Analyze the case studies using data mining and business analytics application in different field of business	3

TEXTBOOKS:

1.	James, E.R. (2017). Business analytics. UK: Pearson Education Limited.
2.	Camm, J.D., Cochran, J.J., Fry, M.J., Ohlmann, J.W., Anderson, D.R. (2015), Essentials of Business analyticss, Cengage Learning, Second Edition.
3.	Prasad, R. N., Acharya, S. (2011), Fundamentals of Business analytics, Wiley.
4.	Schniederjans, M.J., Schniederjans, D.G., Starkey, C.M. (2014), Business analytics: Principles, Concepts and Applications, Pearson.

REFERENCES:

1.	Liebowitz, J. (2013), Business analytics: An Introduction, Auerbach Publications.
2.	Hardoon, D.R., and Shmueli, G. (2016), Getting Started with Business analyticss, CRC Press, Taylor & Francis.
3.	Rao, P.H. (2014), Business analytics: An Application Focus, Prentice Hall India.
4.	Sharma, J.K., Khatua, P.K. (2012), Business Statistics, Pearson.
5.	Pinsky, M.A., Karlin, S. (2010), An Introduction to Stochastic Modelling, Academic Press, 4th Edition.
6.	Provost, F. & Fawcett, T. (2013), Data Science for Business: What you need to know about data mining and data-analytics thinking, O'Reilly Media.

E-RESOURCES:

1.	https://onlinecourses.nptel.ac.in/noc20_mg11/preview
2.	https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-mg11/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2	2									3		2	
2	2	1	2								3		3	
3	2	1	3	2							3		3	
4	2	1	3	2							3		3	
5	2	1	3	3							3		3	

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

ME22042	ENTERPRISE RESOURCE PLANNING (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To provide Knowledge on various Modules of Enterprise Resource Planning (ERP) and Related Technologies.
2.	To learn the ERP Modules structure, Purchasing and Sales perspective.
3.	To understand the future direction of Enterprise Resource Planning (ERP).

UNIT I	INTRODUCTION TO BUSINESS ANALYTICS	9

Definition and importance of Business Analytics (BA) - Types of analytics: descriptive, predictive, Models in Business analytics, prescriptive- Role of business analytics in management decision-making - Overview of tools and techniques used in business analytics. Data types and sources - Data cleaning and pre-processing techniques.

UNIT II	DESCRIPTIVE ANALYTICS	9

Introduction to Descriptive analytics – Visualising, and Exploring Data - Descriptive Statistics - Sampling and Estimation - Probability Distribution for Descriptive analytics - Analysis of Descriptive analytics- Exploratory Data Analysis (EDA)- Data visualization techniques - Data manipulation tools like Excel, SQL, or Python libraries (e.g., Pandas)

UNIT III	PREDICTIVE ANALYTICS	9

Introduction to Predictive analytics- Logic and Data Driven Models - Predictive Analysis Modelling and procedure - Data Mining for Predictive analytics. Analysis of Predictive analytics -Time series Analysis and Regression Analysis-Case studies

UNIT IV	PRESCRIPTIVE ANALYTICS	9

Introduction to Prescriptive analytics - Prescriptive Modelling - Non-Linear Optimisation - Demonstrating Business Performance Improvement. Decision trees, Markov Decision Processes- Multi-Criteria Decision Analysis -Case Studies

UNIT V	DATA MINING AND BA APPLICATIONS IN MECHANICAL ENGINEERING	9

Overview of data mining concepts and Machine Learning (ML) algorithms, - Big Data analytics- Introduction to big data concepts and technologies. Applications of BA in predictive Maintenance, Supply Chain Optimization: Energy Efficiency, Product Life cycle Management (PLM)-Performance Monitoring and Optimization- cost optimization-Finance, Marketing, Human Resource Management, Supply Chain, Healthcare.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand ERP concept, Business modelling, Business process and mapping of business modules.	2
CO2	Apply ERP related technologies to information systems practiced in an organization.	2

CO3	Study the ERP modules like finance, sales and distribution, manufacturing, and quality management.	3
CO4	Demonstrate a working knowledge of how data and transactions are integrated in an ERP system to manage the sales order process, production process, and procurement process.	3
CO5	Develop the future directions of ERP implementation in new market, channels, and E-business.	2

TEXTBOOKS:

1.	Bret Wagne and Ellen F. Monk, "Enterprise Resource Planning", Cengage Learning-2008.
2.	Sheikh Khalid, "Manufacturing Resource Planning (MRP II) with Introduction to ERP, SCM and CRM", Tata McGraw—Hill, New Delhi, 2001

REFERENCES:

1.	Christian N. Madu, "ERP and Supply Chain Management", CHI, 2005
2.	Glynn C. Williams, 'Implementing SAP ERP Sales &Distribution", McGraw-Hill-2017

E-RESOURCES:

1.	http://www.retawprojects.com/uploads/An-Overview-Enterprise-Resource-Planning__ERP.pdf
2.	https://www.udemy.com/topic/erp

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2				2						2		2	
2	2				2						3		3	
3	2				2						3		3	
4	2				2						3		3	
5	2				2						3		3	

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

ME22043	INDUSTRIAL ENGINEERING AND MANAGEMENT (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To identify and explain the core functions of management and their significance in achieving organizational goals.
2.	To analyze and streamline work processes in different organizational domains, aiming to eliminate unnecessary steps and improve efficiency.
3.	To develop proficiency to ensure adherence to quality standards and identify areas for improvement.

UNIT I	INTRODUCTION TO MANAGEMENT CONCEPT & ORGANIZATIONAL STRUCTURES	9

Functions of management - Mc- Gregor's Theory X and Theory Y, Maslow's Hierarchy of Human Needs, Mc.Kensey's 7'S, Framework, Organizational Structure – Departmentation – Line and Staff Structure – Span of Management – Matrix Structure, Boundary less Organization, Virtual Organization, Measurement of productivity, factors affecting the productivity.

UNIT II	WORK STUDY & TIME STUDY	9

Method study – definition – objectives, steps of method study, Outline process charts and Flow process charts, Handed process charts, SIMO chart, and micro motion study. Standard performance, scale of rating, factors of affecting rate of working, allowances and standard time determination, Predetermined motion time study, Method time measurement (MTM).

UNIT III	WAGES, INCENTIVES & ERGONOMICS	9

Wage incentive scheme – wages – objectives of a good wage incentive plan – basis of good wage – incentive plan – plan- types of wage – incentive plans. Design of workplaces, influence of climate on human efficiency. Influence of noise, Areas of study under ergonomics, man-machine system. Components of man-machine system.

UNIT IV	INSPECTION AND QUALITY CONTROL	9

Purpose- objectives, Kind of inspection, In process inspection, Inspection of finished goods, SQC-Normal distribution, Poisson distribution, Significance testing, ANOVA, Monte-corlo simulation, Concept of Zero defect.

UNIT V	CURRENT TRENDS	9

Introduction to Agile manufacturing, Lean and Six Sigma, Value Engineering, just in time, Total quality management, Integrated enterprise resource planning, Supply chain and logistics management.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand the fundamental functions of management and their applicability in various organizational contexts.	2
CO2	Demonstrate proficiency in creating work study and time study techniques to enhance productivity and resource utilization within organizations.	3

CO3	Apply the principles of wage incentive schemes and ergonomic design to propose and develop effective compensation plans and workplace layouts.	3
CO4	Utilize statistical quality control techniques to design and implement effective inspection procedures towards achieving the concept of zero defects in manufacturing and service industries.	3
CO5	Analyze operational processes, enhance organizational efficiency, and improve overall performance in diverse business environments through application of current trends in industrial engineering	3

TEXTBOOKS:

1.	Khanna O.P, 'Industrial Engineering and Management', Dhanpat Rai Publications Pvt Ltd, 2010
2.	Ralph M.Barnes , 'Motion and time study design and Measurement of work', Paperback, 2009
3.	M Mahajan, 'Statistical Quality Control' , Dhanpat Rai Publications Pvt Ltd, 2016

REFERENCES:

1.	Telsang, Marland, S. 'Industrial Engineering and Production Management', Chand Publisher, 2006
2.	S Dalela and Sourabh, 'Work Study and Ergonomics ', Chand Publishers, 3rd edition, 2017
3.	Khan M.I, 'Industrial Engineering', New Age International,2nd edition, 2009
4.	Sanders. S and E J McCormick, 'Human Factors in Engineering Design', Mcgraw Hill, New york, 7th Edition,1993.

E-RESOURCES:

1.	https://nptel.ac.in/courses/112/107/112107292/
2.	https://www.coursera.org/courses?query=industrial%20engineering
3.	https://www.intechopen.com/series/33

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	1					2					3	2		3
2	1	2				2					3	2		3
3	1	2				2					3	2		3
4	1	2		2		2					3			3
5				2		2					3			3

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

ME22044	LOGISTICS IN MANUFACTURING, SUPPLY CHAIN AND DISTRIBUTION (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	Gain a comprehensive understanding of the fundamental concepts, principles, and theories underpinning supply chain management.
2.	Analyze various logistic strategies and practices employed in supply chain management to optimize resource utilization and minimize costs.
3.	Examine the role of technology and innovation, such as information systems, automation in enhancing supply chain visibility, agility, and responsiveness to dynamic market demands.

UNIT I	INTRODUCTION TO LOGISTICS	9

Definition, Types, Concept of logistics management, Logistics vs SCM, logistics functions, inbound and out bound logistics, bullwhip effects in logistics, efficiency, and effectiveness in enhancing overall business performance.

UNIT II	PROCUREMENT AND MANUFACTURING	9

Dimensions of product quality, Procurement Perspectives Procurement Strategies, E-Commerce and Procurement - Manufacturing: Manufacturing Perspectives, Manufacturing cost & strategies, Manufacturing, Facility location- factors influencing plant location-Manufacturing model without shortage, Material Requirement planning (MRP), Bill of material (BOM)

UNIT III	LOGISTICS AND SUPPLY CHAIN MANAGEMENT	9

Key Drivers of Supply Chain Management and Logistics relationships, Basics of Transportation, Transportation Functionality and Principles; Multimodal Transport: Modal Characteristics; Modal Comparisons; Less-than Container Load (LCL) - Full Container Load(FCL), Inland Container Depot, CONCOR.

UNIT IV	DISTRIBUTION MANAGEMENT FOR GLOBAL SUPPLY CHAIN	9

Functions of distribution –marketing forces affecting distribution, designing and choice of distribution channel– factors affecting, Distribution control – stages of control process – standards & goals-measurement – monitoring – corrective action, Distribution Channel Structure – Logistic Requirements of Channel Members – Logistics Support to Distribution Channel.

UNIT V	INTERNATIONAL LOGISTICS MANAGEMENT	9

Recent Trends in World Trade – Leading players – India's Foreign Trade – Commodity Composition and Destination - Overview of International Logistics Components, Importance, Objectives; Benefits of Logistics Outsourcing – Third Party Logistics (3PL) – Fourth Party Logistics (4PL) – Value Added Services.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand the key drivers of Supply Chain Management and the dynamics of logistics relationships.	2

CO2	Demonstrate proficiency in the basics of procurement and manufacturing and make informed decisions regarding transportation choices within supply chain.	3
CO3	Evaluate the functionality and principles of multimodal transport by comparing and contrasting modal characteristics.	3
CO4	Analyze the functions and forces affecting distribution in global supply chains, and design effective distribution channels.	3
CO5	Assess recent trends in world trade, including trade dynamics, commodity composition, and comprehend the objectives, and benefits of international logistics management.	3

TEXTBOOKS:

1.	Bowersox, Closs, Cooper, 'Supply Chain Logistics Management', McGraw Hill, 2009
2.	John J Coyle, C John Langley Jr., Robert A Novack, Brain J Gibson, 'Managing Supply Chains: A Logistic Approach', Cengage Learning India Private Limited, 9th edition, 2013

REFERENCES:

1.	D K Agrawal, 'Distribution and Logistics Management: A Strategic Marketing Approach', Macmillan publishers India, 2007
2.	Yossi Sheffi, 'The New (Ab)Normal: Reshaping Business and Supply Chain Strategy Beyond Covid-19', Amazon Digital Services LLC, 2020
3.	Rushton A, Croucher P, Baker P, 'The Handbook of Logistics and Distribution Management' 5th edition, Kogan Page, New Delhi, 2014

E-RESOURCES:

1.	https://onlinecourses.nptel.ac.in/noc23_mg71/preview
2.	https://www.coursera.org/specializations/supply-chain-management?irgwc=1

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	1								2		3	1		3
2	2	2							2		3	2		3
3	2	2		2		2					3	2		3
4	2	2		2		2					3	2		3
5		2		2		2					3	2		3

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

ME22045	SUSTAINABLE SUPPLY CHAIN MANAGEMENT (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To understand the principles and importance of sustainability in supply chain management and its relevance to Sustainable development goals.
2.	To examine components like green procurement and logistics and evaluate procurement's role in sustainability.
3.	To discuss strategy, performance measurement, and analyze emerging trends such as risk in logistics, block chain technology, and successful sustainability initiatives.

UNIT I	INTRODUCTION TO SUSTAINABLE SUPPLY CHAIN MANAGEMENT	9

Definition and importance of sustainability-Supply chain sustainability, Environmental, social, and economic aspects of sustainability, Sustainable development goals (SDGs) and relevance to supply chains, Leveraging connections of consumer, brand and environment sustainability.

UNIT II	COMPONENTS OF SUSTAINABLE SUPPLY CHAINS	9

Green procurement and sourcing-Sustainable logistics and transportation, Energy efficiency and carbon footprint reduction, Waste management and recycling strategies, Triple bottom line approach, Key factors of supply chain sustainability.

UNIT III	PROCUREMENT AND REVERSE LOGISTICS	9

Sustainable Procurement- drivers and barriers, Procurement framework, Ecolabels, Life cycle Assessment (LCA), Profitability vs Environment benefits, Packaging for environment, Circular economy, Reverse logistics, Recycling.

UNIT IV	STRATEGY AND PERFORMANCE MEASUREMENT	9

Sustainable supply chain performance measurement, Sustainability metrics and reporting frameworks, Theoretical motivations underlying corporate and sustainable strategy, Assessing sustainable choices and initiatives, Sustainability metrics and reporting frameworks, Environment Management System (EMS).

UNIT V	EMERGING TRENDS AND CHALLENGES	9

Recent Trends in World Trade – Leading players – India's Foreign Trade – Commodity Composition and Destination - Overview of International Logistics Components, Importance, Objectives; Benefits of Logistics Outsourcing – Third Party Logistics (3PL) – Fourth Party Logistics (4PL) – Value Added Services.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand economic, ecological, and social aspects of Sustainable supply chain and relate Sustainable Development goals to supply chain.	2
CO2	Identify the key components of sustainable supply chains and evaluate strategies in order to improve sustainability in supply chains.	3
CO3	Evaluate the role of procurement in promoting sustainability and appraise the trade-offs between profitability and environmental benefits.	3

CO4	Analyze strategies for measuring and improving the sustainability performance by understanding the underlying sustainability strategies.	3
CO5	Identify and assess mitigation of risks in logistics through analysis of case studies showcasing successful sustainability initiatives.	3

TEXTBOOKS:

1.	David B. Grant, Chee Yew Wong & Alexander Tautism, "Sustainable Logistics and Supply Chain Management Second Edition" , Kogan Page Publication, 2017
2.	Yann Bouchery, Charles J. Corbett, Jan C. Fransoo, Tarkan Tan, "Sustainable Supply Chains-A Research-Based Textbook on Operations and Strategy", Springer publication, 2017

REFERENCES:

1.	Satish C. Ailawadi & Rakesh Singh: Logistics Management, Prentice-Hall of India Pvt Ltd., New Delhi, second edition, 2005
2.	Sarika Kulkarni: Supply Chain Management, Tata McGraw Hill Publishing Co Ltd., New Delhi, 2005
3.	Krishnaveni Muthiah: Logistics Management & World Sea borne Trade, Himalaya Publishing House, Mumbai, 2011

E-RESOURCES:

1.	https://nptel.ac.in/courses/110108056
2.	https://www.edx.org/learn/supply-chain-management/massachusetts-institute-of-technology-sustainable-supply-chain-management

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2						3	1			2			2
2	2						3	1			2			2
3	2		2			1	3				2			2
4	2		2			1	3				2	2		2
5	2		2			1	3				2	2		2

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

ME22046	TOTAL QUALITY MANAGEMENT (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To facilitate the understanding of Quality Management principles and processes.
2. To learn TQM & process monitoring techniques.
3. To know about various quality management system implemented in industries.

UNIT I	INTRODUCTION	9

Fundamentals of TQM – Historical developments – important philosophies: Deming, Juran, Crossby, Ishikawa and their impact of quality – Quality planning, Quality statement – Vision, Mission, Quality policy.

UNIT II	TQM PRINCIPLES	9

Customer focus - Customer satisfaction – customer perception - customer complaints -Customer Relationship Management (CRM), Employee involvement – Empowerment and Teamwork- Recognition and Reward – Performance appraisal - Supplier Quality Management –Supplier Relationship Manager (SRM)- Supplier Rating – Supplier rating by Analytical Hierarchical Process (AHP)

UNIT III	PROCESS MONITORING	9

Statistical fundamentals – Normal curve charts for variables and attributes- Process Capability analysis, PDSA cycle, 5S, Kaizen, Poke yoke- 7 quality control (QC) tools, New 7 management tools, Pillars of TPM-Implementation of TPM -Case Study

UNIT IV	TQM TECHNIQUES	9

Quality Functions Deployment (QFD) – House of Quality (HOQ), QFD process and benefits, FMEA – concept, Industrial case studies on DFMEA and PFMEA – Lean Six Sigma – -Methodologies-Case Study, Benchmarking process, Taguchi Quality Loss function.

UNIT V	QUALITY MANAGEMENT SYSTEMS	9

ISO 9000 standards and certification, Implementation of QMS in organizations, Auditing and continuous improvement in QMS- ISO 14000 standards and certification, Implementation - OSHAS 18000- Ethical considerations in quality management-- Applications of Information technology - I 4.0, IoT, Machine Vision- ML and DL and Big data analytics in quality management - Case studies.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Describe the evolution and concepts of quality and Total Quality Management.	2
CO2	Discuss the principles of TQM with an industrial applications	2
CO3	Illustrate process monitoring tools and relate with industrial examples.	3
CO4	Apply the various techniques of TQM in industries	3
CO5	Elucidate the need for Quality Management systems in industries	2

TEXTBOOKS:	
1.	Dale H. Besterfiled, et at., "Total quality Management", Third Edition, Pearson Education Asia, Indian Reprint, 2006.
2.	Poornima M. Charantimath, Total Quality Management, Pearson education, 3rd edition, 2017
REFERENCES:	
1.	Satish C. Ailawadi & Rakesh Singh: Logistics Management, Prentice-Hall of India Pvt Ltd., New Delhi, second edition, 2005
2.	Sarika Kulkarni: Supply Chain Management, Tata McGraw Hill Publishing Co Ltd., New Delhi, 2005
3.	Krishnaveni Muthiah: Logistics Management & World Sea borne Trade, Himalaya Publishing House, Mumbai, 2011
E-RESOURCES:	
1.	https://nptel.ac.in/courses/110/104/110104080/
2.	https://nptel.ac.in/courses/110/104/110104085/

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2					3					2			3
2	2										2			3
3	2	2		2	2						2			3
4	2	2		2	2						2			3
5	1				2	3	2				2			3

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

ME22047	WAREHOUSING AUTOMATION (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	Understand the principles and technologies of warehousing automation.
2.	Apply theoretical knowledge in designing, implementing, and managing automated warehouse.
3.	Evaluate the challenges and considerations in implementing warehousing automation solutions.

UNIT I	FUNDAMENTALS OF WAREHOUSE AUTOMATION	9

Warehouse Process - Understanding Warehouse Challenges - Slow fulfilment - Picking errors - Labor shortages and safety concerns - Warehouse Automation Technologies – Types and Benefits - - Carousels, Shuttles and Cranes - Conveyor Systems - Picking and Packing Robots - layouts.

UNIT II	QUEUING THEORY	9

Concepts and Terminology - Queuing Models - M/M/1 and M/M/c – Analysis of order picking and packing - Identification of bottlenecks and congestion points - Service Level Management - Average wait time and queue length - Forecasting queuing behaviour and demand fluctuations - Proactive identification and mitigation.

UNIT III	PLANNING AND IMPLEMENTATION	9

Project Planning and Feasibility Analysis - Cost analysis, ROI calculations and risk assessment - Technology Selection and Integration - Warehouse Management Software - ASRS - Robotic system - Strategies for testing and validating automation systems - Monitoring key performance indicators (KPIs) - Continuous Improvement - warehouse automation solutions in a virtual environment.

UNIT IV	DECISION-MAKING PROCESS IN WAREHOUSE AUTOMATION	11

Overview - Design and Implementation - Business goals and objectives - Technology Selection and Investment Decisions - Cost, Scalability, and Compatibility in technology - Optimal deployment strategy - SWOT Analysis - Cost-Benefit Analysis - Decision Trees - Pareto Analysis - Multi-Criteria Decision Analysis (MCDA).

UNIT V	ADVANCED TECHNOLOGIES AND FUTURE TRENDS	7

Predictive Maintenance, Demand Forecasting, Optimization and Next-generation automation solutions - Drones and Autonomous Mobile Robots - Augmented Reality (AR) and Virtual Reality (VR) - Connected Warehouse - potential disruptions from technologies like hyper loop delivery systems, 3D printing for on-demand parts and block chain-based inventory management.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Demonstrate a comprehensive understanding of the fundamentals of warehouse automation.	3
CO2	Understand the fundamentals of queuing theory and its relevance to warehouse automation.	4
CO3	Evaluate different types of warehouse automation technologies and their suitability for specific applications.	4

CO4	Evaluate the impact of queuing behaviour on workflow optimization and resource allocation in warehouse operations.	3
CO5	Explore predictive analytics techniques for anticipating and mitigating bottlenecks in warehouse processes.	3

TEXTBOOKS:

1.	Gwynne Richards - 2014, Second edition - Warehouse Management: A complete guide to improving efficiency and minimizing costs in the modern warehouse. Kogan Page. ISBN 978-0-7494-6934-4.
2.	Edward H. Frazelle - 2016, World-Class Warehousing and Material Handling, 2nd Edition. McGraw-Hill Education. ISBN: 9780071842822

REFERENCES:

1.	John J. Bartholdi and Steven T. Hackman - 2019, Warehouse & Distribution Science. Georgia Institute of Technology, Atlanta.
2.	Mykel J. Kochenderfer – 2015, Decision Making Under Uncertainty: Theory and Application. MIT Press. ISBN: 9780262331708.

E-RESOURCES:

1.	www.warehouse-science.com
2.	https://www.udemy.com/course/artificial-intelligence-in-warehouse-management/?couponCode=NVDPRODIN35

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2									1	2	
2	3	3	2									1	1	
3	3	3	2									1	1	
4	3	3	2									1	1	
5	3	3	2									1	1	

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

ME22040	PROJECT MANAGEMENT LABORATORY (Common to ME and MN)	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

1.	To provide learners with hands-on experience in utilizing Statistical Package for the Social Sciences (SPSS) software for project management purposes.
2.	To equip learners with practical skills in utilizing Mini tab software for project management tasks.
3.	To provide learners with practical experience in using TORA software for project management applications.

LIST OF EXPERIMENTS:

The following exercise shall be practiced using SPSS and Mini tab	
1.	Import the data into SPSS and calculate descriptive statistics (mean, median, standard deviation) for each variable and discuss how descriptive statistics help in understanding the characteristics of the project for the given dataset.
2.	Conduct correlation analysis using SPSS to identify relationships between different project variables. Interpret the correlation coefficients and discuss their implications for project management decision-making.
3.	Perform multiple regression analysis in SPSS to predict project success metrics (e.g., completion time) based on these factors. Interpret regression coefficients and discuss the significance of predictors in the model.
4.	Conduct time series analysis, including trend analysis and forecasting techniques. Discuss how time series analysis can help in predicting future project trends and making informed decisions.
5.	Conduct one-way ANOVA in SPSS to compare project performance across different categories. Interpret the ANOVA results and discuss potential factors contributing to performance variations.
6.	Perform factor analysis in SPSS to identify underlying factors influencing project management success. Interpret factor loadings and discuss how these factors can inform project management strategies.
7.	Conduct cluster analysis to group projects based on similarities in their characteristics. Interpret cluster results and discuss implications for project portfolio management and resource allocation.
8.	Conduct hypothesis testing (e.g., paired t-test) in SPSS to determine if there is a significant improvement in project performance and discuss the validity of the hypothesis test and implications for project management practice.
9.	Analyze the survey data using SPSS, including calculating descriptive statistics and conducting hypothesis tests and discuss how survey analysis can provide insights into areas for improvement in project management practices.
The following exercise shall be practiced using TORA	
10.	Create a network diagram of a project with various tasks and their dependencies. Calculate the critical path and identify the tasks that are critical for the project completion time. Discuss the implications of critical path analysis on project scheduling and resource allocation.
11.	Apply linear programming techniques to optimize resource allocation while minimizing project duration or cost. Analyze the results and discuss trade-offs between resource utilization and project performance.
12.	Construct a project time-cost trade-off model, considering the relationship between project duration and cost. Use optimization techniques to find the optimal balance between project completion time and cost. Interpret the trade-off curve and discuss strategies for project time-cost management.
13.	Conduct Monte Carlo simulations to assess the impact of risks on project completion time and cost. Analyze simulation results, identify critical risks, and discuss mitigation strategies.

14.	Model a project scheduling problem with precedence constraints and integer programming capabilities. Solve the scheduling problem to minimize project duration while satisfying all task dependencies. Interpret the schedule and discuss the implications of task sequencing on project execution.
15.	Apply resource levelling and smoothing techniques to optimize resource utilization while minimizing project duration. Analyze the impact of resource levelling on project schedules and discuss strategies for resource management.
16.	Construct a decision model and evaluate multiple project alternatives based on their costs and benefits. Use decision analysis techniques (e.g., decision trees, sensitivity analysis) to assess the risk-adjusted value of each alternative. Recommend the most favorable project alternative based on the analysis results.
17.	Model a project quality management problem, considering trade-offs between project cost and quality. Apply optimization techniques to determine the optimal allocation of resources for quality assurance activities. Discuss the role of quality management in project success and the implications of resource allocation decisions.
	TOTAL:PERIODS

CO No.	**COURSE OUTCOMES**	**RBT Level**
At the end of the course, students will be able to:		
CO1	Gain proficiency in navigating the SPSS and Minitab software interface and performing basic operations such as data input, manipulation, and analysis.	3
CO2	Develop the ability to generate meaningful visualizations and reports using SPSS and Minitab to communicate project findings and insights clearly to stakeholders	4
CO3	Generate and interpret TORA output to make informed decisions and recommendations for improving project performance and efficiency.	4

REFERENCES:

1.	Project Management, S.Choudhury , Tata Mecgraw hill education Pvt.Ltd
2.	Project Management - A system approach to planning scheduling nd controlling-Harold kerzner John willy and sons
3.	Project Management, Bhavesh M.Patel,Vikas Publication House, 4002
4.	Project Planning scheduling and control, James P.Lawis, Meo publishing company, 5th edition 4010

E-RESOURCES:

1.	https://onlinecourses.nptel.ac.in/noc24_mg01/preview
2.	https://www.udemy.com/courses/business/project-management/

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1.	2	2		3	2						2		2	
2.	2	2		3	2						3		3	
3.	2	2		3	2						3		3	

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

LIST OF EQUIPMENT FOR A BATCH OF 30 USERS		
SL.No.	**LIST OF EXPERIMENTS**	**Qty.**
1.	Computer Server	1
2.	Computer nodes or systems (High end CPU with at least 1 GB main memory) networked to the server	30
3.	Laser Printer	1
4.	SPSS software	Freeware
5.	Minitab & TORA	Freeware
6.	Licensed operating system	Adequate

VERTICAL 5

CLEAN AND GREEN ENERGY TECHNOLOGIES

ME22051	BIOMASS CONVERSION AND BIOREFINERY (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To impart basic knowledge on biomass composition, properties and its availability.
2.	To teach the biomass conversion techniques and methods used in biorefinery.
3.	To teach the characterization and production of biofuels.
4.	To educate about the environmental and economic sustainability of advanced biomass conversion and biorefinery processes.
5.	To impart the future perspectives and challenges of biomass conversion techniques.

UNIT I	INTRODUCTION TO BIOMASS	7

Definition and types of biomass-Biomass composition and properties-Global biomass resources and availability.

UNIT II	BIOMASS CONVERSION TECHNOLOGIES AND BIOREFINERY CONCEPTS	10

Thermochemical conversion: pyrolysis, gasification, combustion-Biochemical conversion: fermentation, enzymatic hydrolysis-Physical conversion: densification, torrefaction. Biorefinery overview and principles-Types of biorefineries: biochemical, thermochemical, hybrid-Biorefinery process integration and optimization.

UNIT III	BIOFUELS PRODUCTION AND PRODUCTS	10

Bioethanol production: feedstock selection, pretreatment, fermentation-Biodiesel production: transesterification, feedstock options-Biogas production: anaerobic digestion, methane captures. organic acids, alcohols, and others-Biopolymers and bioplastics-Value-added products from biorefinery streams.

UNIT IV	SUSTAINABILITY AND LIFE CYCLE ASSESSMENT	9

Environmental impacts of biomass conversion and biorefinery processes-Economic feasibility and techno-economic analysis-Social implications and stakeholder engagement.

UNIT V	FUTURE PERSPECTIVES AND CHALLENGES	9

Future prospects of biomass conversion and biorefinery-Challenges and opportunities in scaling up biorefinery operations-Policy and regulatory frameworks supporting bio-based industries.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand the basic concepts of biomass composition, properties and its availability.	2
CO2	Acquire the knowledge on biomass conversion techniques and methods used in biorefinery.	3
CO3	Understand the feed stock preparation , characterization and production of biofuels.	2
CO4	familiarize the environmental and economic sustainability of biomass conversion and biorefinery processes.	3

CO5	Acquire the future perspectives and challenges of biomass conversion techniques.	3

TEXTBOOKS:

1.	P K Srivasthava, Elementary Bio physics - An Introduction, Narosa Pub.-2005
2.	Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Pearson. 2011.
3.	Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, CL Engineering, 2015.
4.	Shuler M.L., Kargi F., Bioprocess Engineering, Prentice –Hall, 1992.

REFERENCES:

1.	Doran P.M., ―Bioprocess Engineering Principles‖, Academic Press, 2e, 2012.
2.	Ladisch, M.R., "Bio separations Engineering: Principles, Practice, and Economics", John Wiley & Sons, 2001.
3.	Moheimani, N. R, Boer M. P. M. K, Parisa A, and Bahri, "Biofuel and Biorefinery Technologies", Volume 2, Springer, 2015.
4.	Lee S, Shah Y.T, "Biofuels and Bioenergy". CRC, Taylor & Francis, 2013.
5.	Roger, H., "Bio-separations Science and Engineering", Oxford University Press, 2006.
6.	S. Yang, H.A. El-Enshasy, N. Thongchul (Eds.), "Bioprocessing Technologies in Biorefinery for Sustainable Production of Fuels, Chemicals and Polymers", Wiley, 2013.
7.	Shang-Tian Yang (Ed.), "Bioprocessing for Value Added Products from Renewable resources", Elsevier, 2007.

E-RESOURCES:

1.	https://steamaxindia.com/chapter-1-introduction-to-biomass-energy/
2.	https://ypte.org.uk/factsheets/renewable-energy-biomass-energy/introduction
3.	https://link.springer.com/journal/13399/aims-and- scope
4.	https://www.intechopen.com/chapters/73832
5.	https://www.climatehubs.usda.gov/hubs/northwest/topic/biofuel-production
6.	https://en.wikipedia.org/wiki/Biofuel
7.	https://archive.nptel.ac.in/courses/103/103/103103207/

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2										3	
2	3	3	2										3	
3	3	3	2										3	
4	3	3	2										3	
5	3	3	2										3	

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

ME22052	CARBON FOOTPRINT ESTIMATION AND REDUCTION TECHNIQUES (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To introduce climate change and carbon footprint.
2.	To study the principle of product life cycle and Green House Gas emissions accounting.
3.	To study the Methodology for Carbon Footprint Calculation.
4.	To learn emission mitigation and carbon sink.
5.	To study the case study of carbon footprint.

UNIT I CLIMATE CHANGE AND CARBON FOOTPRINT 9

Green House Effect and Climate Change - Causes and Impacts of Climate Change – Economic implications of Climate Change -IPCC Reports and Projected Climate Change Scenarios – Green House Gas (GHG) Emission – Carbon footprint of Activities, Processes, Products and Services of Organisations – GHG Emission factors and Calculations

UNIT II PRODUCT LIFE CYCLE AND GHG EMISSIONS 9

Life-cycle GHG Accounting - Principles of Product Life Cycle GHG Accounting and Reporting - Fundamentals of Product Life Cycle GHG Accounting - Establishing the Scope of a Product Inventory- GHG Emission Inventories and Accounting - Collecting Data and Assessing Data Quality- Allocation and Assessing Uncertainty.

UNIT III METHODOLOGICAL ASPECTS OF CARBON FOOTPRINT 9

Methodology for Carbon Footprint Calculation in Crop and Livestock Production, End of Life Scenarios and Carbon Footprint of Wood Cladding, Carbon Footprints and Greenhouse Gas Emission Savings of Alternative Synthetic Biofuels, Making Food Production GHG Efficient, Carbon Footprint of Wood-Based Products and Buildings, Challenges and Merits of Choosing Alternative Functional Units, modeling aspects of carbon footprint, Quantifying Spatial–Temporal Variability of Carbon Stocks and Fluxes.

UNIT IV EMISSION MITIGATION AND CARBON SINK 9

Setting GHG Reduction Targets and Tracking Inventory Changes – Non-Fossil Fuel based Energy Systems - Carbon Dioxide capture and Storage Technologies –Mitigation potentials of different Sectors and systems – Innovation, Technology Development and Transfer, - Social aspects of mitigation – Policies, Institutions and international corporations – Carbon Pricing and Finance –GHG Offsetting and Green marketing.

UNIT V CASE STUDIES 9

Carbon Footprint Estimation from Building Sector - Urban Carbon Footprint Evaluation - Applications of carbon footprint in urban planning – Mechanical Equipment and Electronic Product Carbon Footprint - Carbon Footprint of Aqua and Agriculture products- GHG Emissions from Municipal Wastewater Treatment and Solid waste management.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Explain the climate change and carbon footprint.	2
CO2	Discuss the principle of product life cycle and Green House Gas emissions accounting.	3
CO3	Explain the Methodology for Carbon Footprint Calculation.	2
CO4	Discuss emission mitigation and carbon sink.	3
CO5	Explain the case study of carbon footprint.	2

TEXTBOOKS:

1.	Assessment of Carbon Footprint in Different Industrial Sectors, Volume 1, by Subramanian Senthilkannan Muthu, Springer; Softcover reprint of the original 1st ed. 2014 edition (23 August 2016), ISBN-10 : 9811011737.
2.	Assessment of Carbon Footprint in Different Industrial Sectors, Volume 2, by Subramanian Senthilkannan Muthu, Springer Nature; 2014th edition (30 April 2014), ISBN-10: 9814585742.

REFERENCES:

1.	Subramanian, Senthil Kannan, Muthu (2016), Carbon Footprint Handbook, CRC Press.
2.	Subramanian, Senthil Kannan, Muthu (2016), Environmental Carbon Footprint Industrial case Studies, Butterworth Heinemann Publishers.
3.	World Resources Institute, Green House Gas Protocol - Product Life Cycle Accounting and Reporting Standard.
4.	ISO 14067 -2018, Green House gases and carbon footprint, Requirements and Guidelines for Quantification, International Organisation for Standardisation.
5.	IPCC (2022) –Sixth Assessment Reports – Intergovernmental Panel on Climate Change, United Framework convention on Climate Change.
6.	Matthew John Franchetti, Defne Apul "Carbon Footprint Analysis: Concepts, Methods, Implementation, and Case Studies" CRC Press,2012.

E-RESOURCES:

1.	https://onlinecourses.nptel.ac.in/noc23_ar25/
2.	https://sustainability-academy.org/product/online-certificate-on-carbon-reduction-strategy/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2					2	2						3	
2	2					2	2						3	
3	2					2	2						3	
4	2					2	2						3	
5	2					2	2						3	

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

ME22053	ENERGY CONSERVATION AND WASTE HEAT RECOVERY (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To teach the importance of thermodynamic cycles in energy conservation.
2.	To teach various methodologies adopted in industry
3.	To teach the application of WHR system for heating and cooling purpose
4.	To teach the application of the WHR system for direct conversion of heat into electricity.
5.	To teach the economic calculation of WHR to find the economic viability of the same.

UNIT I	**THERMODYNAMIC CYCLES**	**9**

Introduction to Thermodynamic cycles - The Carnot cycle – Rankine cycle - Ideal and actual Rankine cycles – Cogeneration – Kalina cycle - Advantages and drawbacks. Brayton cycle – Improvement in the cycle – Sources of Waste heat.

UNIT II	**WASTE HEAT RECOVERY (WHR) METHODOLOGIES**	**9**

Exergy analysis – Utilization of industrial waste heat – Properties of exhaust gas – Gas to liquid and gas to gas heat recovery systems – Joule heating - Recuperators and regenerators; qualitative treatment – shell and tube heat exchangers – TEMA – Waste heat boilers and its types.

UNIT III	**WHR – APPLICATIONS – LOW, MEDIUM AND HIGH TEMPERATURES**	**9**

LT Applications – Refrigeration – Cryogenics - Loop Heat Pipe - HVAC. MT applications – Food Industry Energy use in the drying Industries – HT Applications – Steel Industry – Ceramic industry – Various process industries case study.

UNIT IV	**WHR – HEAT ENERGY TO ELECTRICAL ENERGY**	**9**

Thermo Electric Generators (TEG) – Working Principle – Thermodynamic analysis – efficiency of the conversion – The Seebeck Effect. The Peltier Effect -Applications of the Peltier Effect. Thomson Effect.

UNIT V	**ECONOMICS OF WHR**	**9**

Waste heat recovery calculations - Available heat - Pinch analysis - typical energy costs – construction costs – pay back analysis - thermo-economic viability.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Estimate the potential of waste heat from a system using thermodynamic cycles.	3
CO2	Analyze the various technologies available for the WHR.	4
CO3	Determine the working parameters of the WHR system for the heating/cooling applications.	3
CO4	Design the working parameters of the WHR system for direct conversion (Heat to Electrical) applications.	3
CO5	Do the financial analysis to determine the economic viability of WHR systems.	3

TEXTBOOKS:

1. Hussam Jouhara "Waste Heat Recovery in Process Industries" – Wiley – 2022.
2. Hewitt, G. F., Shires, G. L., and Bott, T. R. (1993); Process Heat Transfer, CRC Press, Florida.

REFERENCES:

1. Goswami, D. Y., and Kreith, F. (2007); Energy Conversion, CRC Press.
2. Harlock J. H. (1987); Combined Heat and Power, Pergaman Press
3. Kreith F. and West R. E. (1999); Handbook of Energy Efficiency, CRC Press

E-RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc24_mg01/preview
2. https://www.coursera.org/courses?query=project%20management

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2	2									3	
2	3	3	2	2									3	
3	3	3	2	2									3	
4	3	3	2	2									3	
5	3	3	2	2									3	

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

ME22054	ENERGY EFFICIENT BUILDINGS (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To learn the green buildings concepts applicable to alternate design.
2.	To be familiar with basic terminologies related to buildings.
3.	To learn the building (air) conditioning techniques.
4.	To know the methods to evaluate the performance of buildings.
5.	To incorporate Renewable energy systems in buildings.

UNIT I	**INTRODUCTION**	**9**

Climate and Building, Historical perspective, Aspects of green building design – Sustainable Site, Water, Energy, Materials and IAQ, ECBC Standards

UNIT II	**LANDSCAPE AND BUILDING ENVELOPES**	**9**

Energy efficient Landscape design – Microclimate, Shading, Arbors, Windbreaks, Xeriscaping, Building envelope – Thermal comfort, Psychrometry, Comfort indices, Thermal Properties of Building Materials – Thermal Resistance, Thermal Time Constant (TTC), Diurnal Heat Capacity (DHC), Thermal Lag, Decrement Factor, Effect of Solar Radiation – Sol-air Temperature, Processes of heat exchange of building with environment, Insulation

UNIT III	**PASSIVE HEATING AND COOLING**	**9**

HVAC introduction, Passive Heating – Solar radiation basics, Sun Path Diagram, Direct Heating, Indirect Heating and Isolated heating, Concept of Daylighting, Passive Cooling – Natural Ventilation (Stack and Wind), Evaporative Cooling and Radiative Cooling.

UNIT IV	**THERMAL PERFORMANCE OF BUILDINGS**	**9**

Heat transfer due to fenestration/infiltration, Calculation of Overall Thermal Transmittance, Estimation of building loads: Steady state method, network method, numerical method, correlations, Thermal Storage integration in buildings

UNIT V	**RENEWABLE ENERGY IN BUILDINGS**	**9**

Introduction of renewable sources in buildings, BIPV, Solar water heating, small wind turbines, standalone PV systems, Hybrid system – Economics.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Design the climate responsive building.	3
CO2	Calculate the energy load of the buildings.	3
CO3	Determine the passive (air) conditioning parameters.	3
CO4	Evaluate the performance of buildings.	3
CO5	Develop the renewable energy models suitable for the buildings.	3

TEXTBOOKS:	
1.	Baruch Givoni: Climate considerations in building and Urban Design, John Wiley & Sons, 1998
2.	Baruch Givoni: Passive Low Energy Cooling of Buildings by John Wiley & Sons, 15-Jul-1994
3.	Ana-Maria Dabija, "Energy Efficient Building Design", Springer Cham, 2020
REFERENCES:	
1.	Jos´ e Manuel and ´ujar and Sergio G´omez Melgar "Energy Efficiency in Buildings Both New and Rehabilitated.
2.	Mili Majumdar, "Energy Efficient Buildings in India", TERI, Ministry of Non-Conventional Energy Resources 2009
E-RESOURCES:	
1.	https://nptel.ac.in/courses/105102175
2.	https://www.udemy.com/share/1038lO/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	2	1									3	
2	3	3	2	1									3	
3	3	3	2	1									3	
4	3	3	2	1									3	
5	3	3	2	1									3	

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

ME22055	ENERGY STORAGE DEVICES (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To inculcate the concept of the various types of energy storage.
2.	To impart the knowledge of various types of energy storage materials and design Latent Heat Storage System
3.	To enlighten the types of hydrogen and biomass energy storage.
4.	To impart Knowledge in Fundamental concept of batteries
5.	To educate about various alternate energy systems.

UNIT I	INTRODUCTION	9

Necessity of energy storage–types of energy storage–comparison of energy storage technologies–Sensible Heat Storage Systems-Latent Heat Storage Systems, Applications

UNIT II	THERMAL STORAGE SYSTEM	9

Thermal storage–Types–Simple water and rock bed storage system–pressurized water storage system–Modelling of phase change storage system –Simple units, packed bed storage units. Design of Latent Heat Storage System: Requirements and Considerations for the Design, Design Methodologies.

UNIT III	HYDROGEN AND BIOGAS STORAGE	9

Hydrogen storage options–compressed gas–liquid hydrogen–Metal Hydrides, chemical Storage, Biogas storage-comparisons. Safety and management of hydrogen and Biogas storage - Applications.

UNIT IV	ELECTROCHEMICAL STORAGE	9

Fundamental concept of batteries, Materials, Principle of Operation, Positive electrode materials, negative electrode materials, electrolytes.

UNIT V	ALTERNATE ENERGY STORAGE TECHNOLOGIES	9

Flywheel, Super capacitors, Principles & Methods–Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Acquire the capability to recognize energy storage technologies suitable for specific applications.	2
CO2	Grasp the concepts and functioning of thermal energy storage systems, as well as design such systems.	3
CO3	Investigate the operational principles of Hydrogen and Biogas storage systems.	3
CO4	Summarize the concepts related to electrochemical storage and various types of batteries.	2
CO5	Understand the techniques employed in supercapacitors, flywheels, and compressed energy storage systems	2

TEXTBOOKS:	
1.	Thermal Energy Storage Technologies for Sustainability Systems Design, Assessment and Applications, Kalaiselvam, S., Parameshwaran, R., Elsevier, 2014.
2.	Advances in Thermal Energy Storage Systems - Methods and Applications, Luisa F. Cabeza, Elsevier Wood head Publishing, 2015Robert Huggins, Energy Storage: Fundamentals, Materials and Applications, 2nd edition, Springer, 2015
3.	Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, Wiley publications, 2012
REFERENCES:	
1.	Thermal Energy Storage: Systems and Applications, Ibrahim Dinçer, Marc A. Rosen, John Wiley & Sons Ltd., 2010.
2.	David Linden, Handbook of Batteries, McGraw-Hill, Inc), 4th edition, New York. 2010.
3.	National Energy Technology Laboratory, U.S. Department of Energy, Fuel Cell Handbook (Seventh Edition). November 2002.
E-RESOURCES:	
1.	https://nptel.ac.in/courses/113105102
2.	https://onlinecourses.nptel.ac.in/noc21_ch11/preview
3.	https://www.youtube.com/watch?v=0FSEKHc-COA

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2	2										3	
2	3	2	2										3	
3	3	2	2										3	
4	3	2	2										3	
5	3	2	2										3	

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

ME22056	HYDROGEN ENERGY: PRODUCTION, STORAGE, TRANSPORTATION AND SAFETY (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand the basic concept of Hydrogen Energy.
2. To understand the basic concept of Hydrogen production and Storage devices.
3. To familiarize about Hydrogen energy transportation and safety

UNIT I	HYDROGEN – BASICS AND PRODUCTION TECHNIQUES	9

Hydrogen: global status of supply and demand – physical and chemical properties, salient characteristics. Production of hydrogen – methane decomposition - steam reforming – water electrolysis – gasification and woody biomass conversion – biological hydrogen production – photo dissociation – direct thermal or catalytic splitting of water.

UNIT II	HYDROGEN STORAGE AND APPLICATIONS	9

Novel materials for solid state hydrogen storage - Hydrogen storage options – Compressed gas – Liquid hydrogen – Metal hydrides – Chemical storage, Hydrogen energy chain: Transport, Stationary power, Portable power and other applications, Environmental concerns, and cost – Safety and management of hydrogen, Applications of Hydrogen

UNIT III	HYDROGEN TRANSPORTATION	9

Hydrogen pipelines - Liquid hydrogen transportation - High-pressure tube trailers - Hydrogen carriers (ammonia, liquid organic hydrogen carriers) - Integration with existing fuelling infrastructure.

UNIT IV	HYDROGEN SAFETY	9

Hydrogen properties and hazards - classification of hydrogen hazards: compressed and liquid hydrogen related hazards- Risk assessment and mitigation strategies - Codes and standards for hydrogen safety - Case studies of hydrogen incidents.

UNIT V	HYDROGEN FUTURE DIRECTIONS	9

Renewable hydrogen production methods - Hydrogen economy and policy implications - Emerging trends and research challenges in hydrogen technology – Case studies: utilization of hydrogen in various sectors, global status and future directions.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand the fundamental knowledge on hydrogen production techniques	2
CO2	Evaluate the details of different methods of hydrogen storage technologies	3
CO3	Analyse the challenges and opportunities associated with the transportation of hydrogen and develop strategies	3
CO4	Develop the protocols and regulations governing the production, storage, and transportation of hydrogen	3
CO5	Apply principles of sustainability and environmental impact assessment to hydrogen energy systems	3

TEXTBOOKS:

1.	Gupta, R. B., Hydrogen Fuel: Production, Transport and Storage, CRC Press, Taylor & Francis Group, 2009
2.	Kazunari Sasaki., Hydrogen Energy Engineering, 2016
3.	Michael Hirscher, "Handbook of Hydrogen Storage", Wiley-VCH, 2010.

REFERENCES:

1.	Global Hydrogen Review 2021, IEA (2021), Paris, https://www.iea.org/reports/global-hydrogen-review-2021
2.	Agata Godula-Jopek, Hydrogen Production by Electrolysis, Wiley-VCH, Germany, 2015
3.	Tzimas, E., Filiou, C., Peteves, S.D., &Veyret, J.B. "Hydrogen storage: state-of-the-art and future perspective. Netherlands": European Communities, 2003.

E-RESOURCES:

1.	https://onlinecourses.nptel.ac.in/noc24_me68/preview
2.	https://onlinecourses.nptel.ac.in/noc22_ch66/preview

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2	2				2						3	
2	3	2	3				2						3	
3	3	2	3				2						3	
4	2	2	2				2						3	
5	2	2	2				2						3	

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

CH22041	RENEWABLE ENERGY RESOURCES (Common to CH, ME, MN and MR)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	Understand energy scenario, energy sources and their utilization.
2.	Explore society's present needs and future energy demands.
3.	Study the principles of renewable energy conversion systems.
4.	Exposed to energy conservation methods.

UNIT I INTRODUCTION **9**

Introduction: Principles of renewable energy; energy and sustainable development, fundamentals, and social implications. worldwide renewable energy availability, renewable energy availability in India, brief descriptions on solar energy, wind energy, tidal energy, wave energy, ocean thermal energy, biomass energy, geothermal energy, oil shale. Introduction to Internet of energy (IOE).

UNIT II SOLAR ENERGY **9**

Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Solar radiation Measurements- Pyrheliometers, Pyrometer, Sunshine Recorder. Solar Thermal systems: Flat plate collector; Solar distillation; Solar Pond electric power plant. Solar electric power generation- Principle of Solar cell, Photovoltaic system for electric power generation, advantages, Disadvantages, and applications of solar photovoltaic system.

UNIT III WIND AND BIOMASS ENERGY **9**

Wind Energy: Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, Basic components of wind energy conversion system (WECS); Classification of WECS- Horizontal axis- single, double and multiblade system. Vertical axis- Savonius and darrieus types.

Biomass Energy: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies-fixed dome; Urban waste to energy conversion; Biomass gasification (Downdraft)

UNIT IV TIDAL AND OCEAN THERMAL ENERGY **9**

Tidal Power: Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, advantages, and limitations.

Ocean Thermal Energy Conversion: Principle of working, OTEC power stations in the world, problems associated with OTEC.

UNIT V GREEN ENERGY **9**

Green Energy: Introduction, Fuel cells: Classification of fuel cells – H_2; Operating principles, Zero energy Concepts. Benefits of hydrogen energy, hydrogen production technologies (electrolysis method only), hydrogen energy storage, applications of hydrogen energy, problem associated with hydrogen energy.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Describe the environmental aspects of renewable energy resources, in Comparison with various conventional energy systems, their prospects and limitations.	3
CO2	Describe the use of solar energy and the various components used in the energy production with respect to applications like-heating, cooling, desalination, power generation	3
CO3	Understand the conversion principles of wind and tidal energy	2
CO4	Understand the concept of biomass energy resources and green energy.	2
CO5	Acquire the basic knowledge of ocean thermal energy conversion and hydrogen energy	3

TEXTBOOKS:

1.	D. Yogi Goswami & Frank Kreith, Energy Efficiency and Renewable Energy Handbook, Second Edition, 2016
2.	Imene Yahyaoui, Advances in Renewable Energies and Power Technologies: Volume 1: Solar and Wind Energies, 2018.
3.	John Twiddel & Tony Weir, Renewable Energy Resources, 2006.

REFERENCES:

1.	Principles of Energy conversion, A. W. Culp Jr., McGraw Hill, 1996
2.	Non-Convention Energy Resources, Shobh Nath Singh, Pearson, 2018

E-RESOURCES:

1.	https://nptel.ac.in/courses/103103206
2.	https://www.coursera.org/courses?query=renewable%20energy

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2	2	2	2	2	2	1	2	3	2	3	3	3	
2	2	2	2	2	3	2	3	2	2	2	3	3	3	
3	2	2	2	2	2	3	3	2	3	3	2	3	3	
4	3	2	3	3	3	3	3	2	3	2	3	2	3	
5	3	3	3	3	3	3	3	3	3	2	3	3	3	

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

ME22050	ENERGY AUDIT - CASE STUDY (Common to ME and MN)	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

1.	To identify the system and various forms of energy that interacts with that system.
2.	To calculate amount of energy that interacts and draw the energy balance diagram
3.	To estimate the various energy losses and irreversibility's.
4.	To find the possible way to ensure the conservation of exergy of the system

METHODOLOGY

1. This subject is going to be conducted as a practical course.
2. Learners will be asked to identify a thermodynamic system in the campus. It may be either a small engine or as big as a laboratory itself.
3. He/ She should carry out the energy and exergy analysis.
4. The learners should submit the same as a technical report.
5. Each analysis, along with the report, will be evaluated for a maximum mark of 50.
6. A learners should submit three such reports in a semester and the corresponding marks will be considered as FAT marks.
7. At the end there would be model and summative examinations.
8. The maximum marks for formative assessment shall be 60%. The criteria for arriving at the Internal Assessment marks of 60 is as follows: Maximum of 40 marks shall be awarded for successful completion of all the three case studies and a model test will be conducted and the mark will be scaled down to 20.
9. The maximum marks for Summative assessment shall be 40%. A summative examination will be conducted for a small thermodynamic system for a maximum mark of 100. Then the mark will be scaled down to 40.

TOTAL: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Identify the system and all the energy interactions.	3
CO2	Know how to calculate the quantity of energy that interacts with the system	3
CO3	Estimate the losses in energy and irreversibility's.	3
CO4	Propose a methodology to conserve the exergy	3

TEXTBOOKS:

1.	Handbook of energy audits / Albert Thumann, William J. Younger, Terry Niehus ©2010 by The Fairmont Press.
2.	W. R. Murphy and F. Mc Kay Butter wort, "Energy Management", 1st edition, Elsevier publications, 2012.

REFERENCES:

1.	Reay, D.A., "Industrial Energy Conservation", 1st edition, Pergamon Press, 2003.
2.	White, L.C., "Industrial Energy Management and Utilization", 1st edition, Hemisphere Publishers, 2002.

3.	Paul O' Callaghan, "Energy Management", 1st edition, Mc-Graw Hill Book Company, 1998.

E-RESOURCES:

1.	https://iisdt.in/product/diploma-in-energy-audit-and-management/
2.	https://www.udemy.com/share/103fdq/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2	1									3	
2	3	3	2	1									3	
3	3	3	2	1									3	
4	3	3	2	1									3	
5													3	

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

VERTICAL 6
SMART MANUFACTURING

MN22061	DIGITAL TWIN AND INDUSTRY 5.0 (Common to MN and ME)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To introduce the concept and significance of Digital Twin technology in modern industries.
2.	To explore the application of Digital Twin within discrete industries.
3.	To explore the application of Digital Twin within process industries.
4.	To understand the evolution and impact of Industry 5.0 on technological advancements.
5.	To critically evaluate the challenges and prospects of Digital Twin.

UNIT I	INTRODUCTION TO DIGITAL TWIN	9

Definition, Evolution and concepts of Digital Twin Technology - Digital Twin in Product Life Cycle Management - Digital twin in industrial application – Challenges of digital twin application – Key Technologies – Eight rules for Digital Twin modeling.

UNIT II	DIGITAL TWIN IN SMART MAUFACTURING	9

Concept of digital twin in shop-floor – Implementation, Key technologies, challenges in shop-floor – Equipment Energy consumption management (EECM) – Framework, Implementation, Advantages of EECM in shop-floor - Physical fusion in shop-floor.

UNIT III	DIGITAL TWIN AND NEW TECHNOLOGIES	9

Introduction to digital twin and cloud, fog, Edge computing – Big data – Lifecycle of big data in manufacturing – Fusion of digital twin and big data – VR, AR in design, manufacturing and service – Digital twin and cyber physical system in manufacturing – Role of IoT in digital twin.

UNIT IV	INDUSTRY 5.0	9

From Industry 4.0 to Industry 5.0: Evolution - Principles and Objectives of Industry 5.0 – Challenges of 5.0 – Benefits of 5.0 – Automation in engineering, manufacturing, business, robotic, digital, intellect process – Process transformation

UNIT V	TECHNOLOGIES AND APPLICATIONS OF INDUSTRY 5.0	9

Internet of Things (IoT) and its applications in Industry 5.0 - Potential of IoT in manufacturing and automation - Artificial Intelligence and Machine Learning in Industry 5.0 - Automation systems in the automobile industry - Challenges and opportunities in implementing.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Apply Digital Twin basics to industrial problems.	3
CO2	Identify Digital Twin uses in manufacturing.	3
CO3	Develop efficiency strategies in process industries using Digital Twins.	3
CO4	Utilize Digital twin knowledge for Industry 5.0	3
CO5	Apply the advantages in industry 5.0.	3

TEXTBOOKS:

1. "Digital Twin – Fundamental Concepts to Applications in Advanced Manufacturing" by Surjya Kanta Pal, Debasish Mishra, Arpan Pal, Samik Dutta, Debashish Chakravarty, Srikanta Pal. Springer International Publishing, August 2021. ISBN:9783030818159, 3030818152

2.	"Industry 5.0: The Future of the Industrial Economy" by Elangovan and Uthayan. United States: CRC Press, 2021. ISBN:9781000484663, 1000484661

REFERENCES:

1.	Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, "Digital Twin Driven Smart Manufacturing", Elsevier Science., United States, 2019
2.	Ibrahim Garbie, "Sustainability in Manufacturing Enterprises, Concepts, analyses and assessments for Industry 4.0", Springer., Switzerland, 2016.
3.	Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation", Springer Series in Advanced Manufacturing., Switzerland, 2018

E-RESOURCES:

1.	https://www.researchgate.net/publication/340055758_Digital_Twin_Technology
2.	https://www.digitaltwinconsortium.org/webinars/
3.	Digital Twins from University of Michigan https://www.classcentral.com/course/digital-twins-55789

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3											1	1	1
2	3		1	2	2							1	1	2
3	3		1	2	2	1						1	1	2
4	3						2	1				2	2	2
5	3		1				2					1	1	1

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

MN22062	DRONE TECHNOLOGIES (Common to MN and ME)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To Understand drone basics and concepts.
2.	To Learn drone design, fabrication, and programming.
3.	To Gain knowledge in flying and operating drones.
4.	To Explore drone applications across sectors.
5.	To Study drone safety, risks, and regulations.

UNIT I	INTRODUCTION TO DRONE TECHNOLOGY AND BASIC AERODYNAMICS	9

Drone Concept and Evolution - Terminology - History of Drones - Fixed Wing and Multi rotor Drones: Introduction, Kinematics, and Dynamics - Types of Current Generation of Drones Based on Propulsion Methods - Drone Technology's Impact on Businesses - Opportunities for Entrepreneurship and Employability in the Drone Sector.

UNIT II	DESIGN, FABRICATION, AND PROGRAMMING OF DRONES	9

Classifications of UAVs and Overview of Main Drone Parts - Technical Characteristics and Functions of Component Parts - Assembling and Fabricating Drones - Energy Sources and Level of Autonomy – Drone Configurations and Propulsion Mechanics - Basics of Drone Programming: Installation and Running Programs – Multi rotor Stabilization and Flight Modes - Wi-Fi Connectivity and Remote Control Operations.

UNIT III	ADVANCED DRONE OPERATIONS AND CONTROL SYSTEMS	9

Operating Drones: Flight Modes and Control Mechanisms - Navigational Sensors and Inertial Systems - Magnetometers, Pressure Sensors, GPS, and Camera-Based Navigation - State Estimation and Attitude Estimation Techniques - Advanced Flight Controls and Motion Planning: PIC Control, Linear Quadratic Regulator (LQR), and Linear Model Predictive Control - Collision-Free Navigation and Structural Inspection Path Planning.

UNIT IV	COMMERCIAL APPLICATIONS AND REGULATORY COMPLIANCE	9

Selecting Drones for Specific Applications - Drones in Various Sectors: Insurance, Agriculture, Delivery Services, Inspection of Infrastructure - Legal and Ethical Considerations in Drone Operations – Specific Aviation Regulations, Standardization, and Drone Licensing - Safety Guidelines and Risk Management in Drone Operations.

UNIT V	FUTURE TRENDS IN DRONE TECHNOLOGY AND SAFETY INNOVATIONS	9

Innovations in Drone Design: Miniaturization and Increased Autonomy - The Use of Drones in Swarms and Collaborative Operations - Emerging Technologies in Drone Safety and Risk Mitigation – Global Trends and Future Prospects in Drone Technology - Ethical Implications and Environmental Considerations in the Development and Use of Drones.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Apply knowledge of drone technologies to solve real-world challenges.	3
CO2	Build and experiment with drone models to understand their design and functionality.	3
CO3	Choose appropriate drone technologies for specific industry applications.	3
CO4	Develop strategies for effective drone operation and management.	3
CO5	Utilize drone technology within legal and ethical guidelines.	3

TEXTBOOKS:

1.	R. Beard, and T. W. McLain, "Small Unmanned Aircraft: Theory and Practice", Princeton University Press, 2012
2.	Daniel Tal and John Altschuld, "Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation", 2021 John Wiley & Sons, Inc.
3.	Chinmaya Ranjan Pattnaik, G. Surya Narayana, "Drone Technology: Future Trends and Practical Applications", June 2023, Wiley Publication. ISBN:9781394166534, 1394166532

REFERENCES:

1.	R. C. Nelson, "Flight Stability and Automatic Control", McGraw Hill, New York, 1998
2.	Terry Kilby and Belinda Kilby, "Make: Getting Started with Drones Manufacturing", Maker Media Inc, 2016, Elsevier Science., United States, 2019
3.	Garvit Pandya, "Basics of Unmanned Aerial Vehicles: Time to start working on Drone Technology" March 2021, Notion Press. ISBN:9781637453872, 1637453876

E-RESOURCES:

1.	Drones for Agriculture: Prepare and Design Your Drone (UAV) Mission - Wageningen University https://www.classcentral.com/course/drones-wageningen-university-research-drones-for--13843
2.	Unmanned Aerial Systems (UAS): Fundamentals - University of Alaska Fairbanks https://www.classcentral.com/course/science-university-of-alaska-fairbanks-unmanned-a-207521

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3												1	1
2	3		2		2				2				2	2
3	3		1	1	2								1	2
4	3					2		2					1	
5	3					2		2				1	1	1

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

MN22063	INDUSTRIAL NETWORK AND PROTOCOL (Common to MN and ME)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To understand the architecture and operation of industrial communication systems.
2.	To learn about various industrial protocols and their applications in automation.
3.	To design and implement network solutions for industrial control systems.
4.	To analyze and troubleshoot industrial networks.

UNIT I	FUNDAMENTALS OF INDUSTRIAL NETWORKS	9

Introduction to Industrial Network – Importance - applications - Overview of OSI and TCP/IP models - Wireless - Wired Networks Comparison - Serial Communication Protocols - RS232 – UART - SPI - I2C –UNI/O Bus-1 Wire-Camera Link - Parallel Communication - PPI - Wishbone Bus – AMBA – JTAG – Fireware - IEEE 1394 Bus - Ethernet Overview - RS485. Fieldbus – Profibus - Modbus; principles, operations, applications. Selection Criteria for Industrial Networks.

UNIT II	INDUSTRIAL ETHERNET AND WIRELESS COMMUNICATION	9

Traditional and Industrial Ethernet - Overview of switches, routers, and gateways specific to industrial applications - Wireless Communication Standards: Antenna Technology - Network Topologies - Wireless Local Area Networks (WLAN) - Wireless Personal Area Networks (WPAN) - Wimedia – Wimax - RF – Bluetooth- Wi-Fi – Zigbee – Wireless Industrial Automation Protocols.

UNIT III	WIRED NETWORKS FOR AUTONOMOUS SYSTEMS	9

Overview of Industrial Wired Networks – Terminal Bus - Modbus - HART Network – Mechatrolink - II – Ether CAT - SERCOS II/III – CAN - CANopen - Modbus IDA - PROFINET- PROFIBUS - Ethernet/IP- Ethernet Power link - AG Automation and Drives (AS-I) - Device Net

UNIT IV	WIRELESS NETWORKS AND NETWORK DESIGN	9

Overview of Industrial Wireless Networks - IWLAN - ISA100 Standards – Remote Networks - Controller-Based Networks - Wireless HART Technology - 3G/4G for Automation – RFID Data Tags. Design Principles - Network topologies - Security in Industrial Networks – Vulnerabilities - Security measures and policies.

UNIT V	TRENDS AND FUTURE DIRECTIONS	9

Review of Industrial IoT (IIoT): Impact of IoT on industrial networking, challenges, and opportunities. Maintenance and Troubleshooting - Role of AI in industrial networks - Wired and Wireless Machine Networking of Sub-elements and Machines –Communication Network Layout Design - Networking for TIA - Cloud Computing Future landscape of industrial networks.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Describe the architecture and operation of different industrial communication systems.	2
CO2	Select and apply appropriate industrial protocols for specific automation tasks.	4
CO3	Design and implement industrial network solutions to meet system requirements.	5

CO4	Troubleshoot and optimize industrial networks for reliability and performance.	4
CO5	Understand the security implications and best practices in industrial networks.	2

TEXTBOOKS:

1.	Dick Caro, "Wireless Networks for Industrial Automation", 4th Edition, International Society of Automation. 2014.
2.	A. Gupta, "Data Communication Principles for Fixed and Wireless Networks," 1st Edition, 2003, Springer.

REFERENCES:

1.	A.V. Bakshi and U.A. Bakshi, "Network Analysis and Synthesis," 1st Edition, 2009, Technical Publications.
2.	William Stallings, adapted by Brijendra Singh, "Wireless Communications & Networks," 2nd Edition, 2010, Pearson India
3.	K.P. Pradeep Kumar, "Automation, Production Systems, and Computer-Integrated Manufacturing," 3rd Edition, 2015, PHI Learning.
4.	Raj Kamal, "Embedded Systems: Architecture, Programming and Design," 3rd Edition, 2013, McGraw-Hill Education.

E-RESOURCES:

1.	https://onlinecourses.nptel.ac.in/noc22_ee61/preview
2.	https://onlinecourses.nptel.ac.in/noc22_cs19/preview
3.	https://www.raspberrypi.org/documentation
4.	https://www.arduino.cc/en/Guide

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2	2	3	2	2			2			3	**1**	**2**
2	3	3	2		2				2			2	3	3
3	3	2	1	1	2							2	2	2
4	3	3	2			2		2				2	2	2
5	3	2	1			2		2				1	2	2

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

MN22064	INTELLIGENT PHYSICAL SYSTEMS (Common to MN and ME)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To acquire knowledge and skills in various hardware and software design aspects of intelligent Physical Systems.
2.	To analyze the functional behavior of intelligent physical systems.
3.	To develop an exposition of the challenges in implementing a cyber-physical system from a computational perspective.

UNIT I	INTRODUCTION TO INTELLIGENT PHYSICAL SYSTEM	9

Intelligent Cyber-Physical Systems in the real world, Basic principles of design and validation of Intelligent Physical Systems in Industry 4.0, Auto SAR, IIOT implications Building Automation, Medical CPS.

UNIT II	NETWORKING AND COMMUNICATION PROTOCOLS	9

Principles of Modulation and Demodulation: Principles of Amplitude and Frequency Modulations- CPS Network - Wireless Hart, CAN, Ethernet, CPS SW stack – RTOS, Scheduling Real-Time control tasks CPS.

UNIT III	LIMITATIONS IN INTELLIGENT PHYSICAL SYSTEM DEPLOYMENT	9

Stability Analysis: CLFs, MLFs, stability under slow switching, Performance under Packet drop and Noise. CPS: From features to automotive software components, Mapping software components to ECUs CPS Performance Analysis - effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion Building real-time networks for CPS.

UNIT IV	INTELLIGENT PHYSICAL SYSTEM APPLICATION	9

Case Study: Suspension Control, Healthcare: Artificial Pancreas/Infusion Pump/Pacemaker, Green Buildings: automated lighting, AC control, Digital Twin system, Safe Reinforcement Learning - Robot motion control - Autonomous Vehicle control.

UNIT V	SECURE DEPLOYMENT OF INTELLIGENT PHYSICAL SYSTEM	9

Attack models, Secure Task mapping and Partitioning, State estimation for attack detection, Automotive Case study: Vehicle ABS hacking, Power Distribution Case study: Attacks on Smart Grids.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Identify the components and techniques required for an intelligent physical system.	2
CO2	elaborate processors, Networking, Communication protocols and programming	3
CO3	Categorize the essential modelling formalisms of intelligent Physical Systems.	3
CO4	Demonstrate the different control systems and applications of intelligent physical systems	4
CO5	develop intelligent systems, security, safety aspects and implementation	3

TEXTBOOKS:	
1.	Rajeev Alu, Principles of Cyber-Physical Systems, The MIT Press, 2016
2.	Edward A. Lee and Sanjit A. Seshia, Introduction to Embedded Systems: A Cyber-Physical Systems Approach, Second edition, MIT Press, 2011
REFERENCES:	
1.	Song, H., Rawat, D. B., Jeschke, S., &Brecher, C. (Eds.). Cyber-physical systems: foundations, principles, and applications. Morgan Kaufmann, 2016
2.	Rodrigues, Joel Jose PC, Ivan Stojmenovic, and Danda B. Rawat. Cyber-physical systems: from theory to practice. CRC Press, 2015.
E-RESOURCES:	
1.	https://onlinecourses.nptel.ac.in/noc23_cs62/preview
2.	https://courses.cornell.edu/preview_course_nopop.php?catoid=31&coid=491066

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2	2		3								2	
2	3	3	2		3								2	
3	3	3	2		3								2	
4	3	3	2		3								2	
5	3	2	1			2		2				1	2	

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

MN22065	MACHINE VISION AND IMAGE PROCESSING (Common to MN and ME)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To understand the principles of image formation and representation.
2.	To learn the core techniques in image processing and analysis.
3.	To apply machine vision algorithms to solve engineering problems.
4.	To design and implement systems for various applications in automation and robotics.

UNIT I INTRODUCTION AND IMAGE FORMATION **9**

Overview of Machine Vision Systems: History and evolution of machine vision - Differences between machine vision and computer vision - Components of a machine vision system. Image Formation Principles: Physics behind image formation - light properties, reflection, refraction, and absorption - Camera models. Lighting and Optics for Machine Vision: Lighting techniques - The selection of optics and lenses - focal length, field of view, and depth of field. Digital Image Fundamentals: Digital image representation - pixel intensity, color models (RGB, HSV) and image formats - Sampling and quantization

UNIT II IMAGE ENHANCEMENT AND RESTORATION **9**

Spatial Domain Methods: Image contrast and brightness - Histogram equalization and local enhancement techniques - Spatial filters for noise reduction. Frequency Domain Methods: Fourier Transforms - image smoothing and sharpening - Frequency domain filters (low-pass, high-pass, band-pass). Advanced Enhancement Techniques: Adaptive filtering techniques - Image content and wavelet transforms for multi-resolution analysis - Noise reduction, enhancing features, and compressing images - Image degradation and restoration.

UNIT III FEATURE EXTRACTION **9**

Edge Detection and Feature Extraction: Gradient-based and Laplacian methods for edge detection - Advanced feature extraction methods - SIFT and SURF. Feature Matching and Applications: Algorithms for matching features across different images - Brute force matching and FLANN based matching - Applications of feature extraction and matching in object recognition - 3D reconstruction - motion tracking.

UNIT IV OBJECT RECOGNITION **9**

Pattern Recognition in Machine Vision: Basics of pattern recognition - Template matching - Statistical classification methods. Deep Learning Approaches: Deep learning in object recognition - Convolutional neural networks (CNNs) - Architecture of CNNs - Training processes. Practical Applications of CNNs: Real-world applications of CNNs in machine vision - Facial recognition - Automated vehicle navigation - Industrial inspection.

UNIT V APPLICATIONS IN SMART MANUFACTURING **9**

The role of machine vision in Industry 4.0 - Real-time monitoring of production lines, automated inspection for quality control, and machine maintenance - The application of machine vision in robotics - robot navigation, object handling, and automated assembly processes - The use of augmented reality for maintenance - The application of machine learning algorithms for predictive analysis.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Analyze and process images using various techniques.	3
CO2	Design and implement machine vision systems.	4
CO3	Apply image processing algorithms for real-world applications.	3
CO4	Work with software tools and libraries relevant to machine vision and image processing.	3
CO5	Analyze and process images using various techniques.	5

TEXTBOOKS:

1.	Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing," 4th Edition, Pearson Education, 2018.
2.	David A. Forsyth and Jean Ponce, "Computer Vision: A Modern Approach," 6th Edition, Pearson, 2020.

REFERENCES:

1.	Milan Sonka, Vaclav Hlavac, and Roger Boyle, "Image Processing, Analysis, and Machine Vision," 5th Edition, Cengage Learning, 2017.
2.	Reinhard Klette, "Concise Computer Vision," Springer, 2014.
3.	Bernd Jahne, "Digital Image Processing," 6th Edition, Springer, 2005.
4.	Anil K. Jain, "Fundamentals of Digital Image Processing," Prentice Hall, 2015.
5.	Scott E Umbaugh, "Digital Image Processing and Analysis," CRC Press, 2011.

E-RESOURCES:

1.	https://onlinecourses.nptel.ac.in/noc23_ee39/preview
2.	https://www.coursera.org/, edX: https://www.edx.org/
3.	https://www.mathworks.com/help/matlab/; https://docs.opencv.org/master/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2			2							1	2	
2	2	3	3	2	3				1	1			3	
3			2		3							2	2	
4	2				2							2	3	
5	2	2	2	1	3	1	1	1	2	2	1	3	2	

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

MN22066	ROBOT OPERATING SYSTEMS Common to MN and ME	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To introduce ROS and programming
2.	To model a robot with URDF
3.	To simulate the robots with Gazebo
4.	To simulate the robots with V-Rep
5.	To do motion planning with MoveIt

UNIT I	INTRODUCTION TO ROBOT OPERATING SYSTEMS	9

Introduction to ROS- Advantages and Disadvantages of ROS - ROS Framework- ROS package C++, Python – ROS computation Graph – nodes, Messages, topics, services, bags, ROS Master- ROS Community- Basic programming and Syntax overview in C++ and Python – start with ROS programming - Creating Environment - Services-Actions and Nodes - Simple Interaction with the Simulation environment.

UNIT II	ROBOT MODELING WITH URDF	9

CAD Tools for Robot Modelling – ROS Packages for robot modelling – Unified Robot Description Format and Tags- Kinematics and Dynamics Library – Create URDF Model – Robot Modelling using Unified Robot Description Format (URDF),-ROS parameter server and adding real-world object representations to the simulation environment _ Create Robot description using 7 DOF: joint number, name, type and angle limits – Xacro – Rviz – viewing of 7 DOF arm – creation of wheeled robot.

UNIT III	ROBOT SIMULATION WITH GAZEBO	9

Robot simulation - Gazebo –create simulation model at Gazebo- Adding colors, textures, transmission tags, 3D vision sensor to Gazebo- Moving robot joints using ROS controllers-ROS controller interacts with Gazebo, interfacing state controller, simulation of moving the robot joints – simulation of differential wheeled robot in Gazebo.

UNIT IV	ROBOT SIMULATION WITH V-REP	9

Simulating the robotic arm using V-REP – Adding the ROS interface to V-REP joint - Simulating a differential wheeled robot, adding a laser sensor, 3D vision sensor.

UNIT V	MAPPING, NAVIGATION, AND MOTION PLANNING ROS WITH MOVEIT	9

Move it Installation - Generating the Self-Collision matrix, virtual joints, planning groups, robot poses, robot end effector - MoveIt Architecture Diagram - Trajectory from RViz GUI executing in Gazebo - Planning scene overview diagram- Collision Checking - Motion Planning, Pick and Place Behaviors using Industrial Robots with ROS MoveIt – ROS with MATLAB.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand ROS and ROS programming	2
CO2	Understand robot modeling and create URDF model	2
CO3	Simulate robots in ROS using Gazebo	3

CO4	Simulate robots in ROS using V-Rep	3
CO5	Understand mapping, navigation, and motion planning using MoveIt	2

TEXTBOOKS:

1.	Lentin Joseph, Jonathan Cacace, "Mastering ROS for Robotics Programming", Second Edition, Packt Publishing, 2018.

REFERENCES:

1.	Lentin Joseph, Aleena Johny, "Robot Operating System (ROS) for Absolute Beginners Robotics Programming Made Easy", Second Edition, Apress, 2022.
2.	Lentin Joseph, "ROS Robotics Projects", Packt publishing, 2017

E-RESOURCES:

1.	https://www.classcentral.com/course/robotics-delft-university-of-technology-hello-rea-11555

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2	2												2
2		2	1		3									2
3	1		1		3									2
4	1		1		3									3
5			1		3									3

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

MN22067	ROBOTICS FOR SMART MANUFACTURING (Common to MN and ME)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To introduce the basic concepts, types of robots, sensors, and actuators.
2.	To familiarize the students about the various applications of robots in manufacturing.
3.	To impart knowledge of robotic vision system in robotic inspection.
4.	To make students understand robotic integration for automation.
5.	To make students learn how AI and ML for robots helps in smart manufacturing.

UNIT I	INTRODUCTION TO ROBOTICS IN MANUFACTURING	9

Overview of smart manufacturing: Industry 4.0, automation, and robotics; Role of robotics in modern manufacturing processes; types of industrial robots: Manipulators, mobile robots, collaborative robots (Cobots); Sensors and actuators in robotic systems for manufacturing

UNIT II	ROBOTIC APPLICATIONS IN MANUFACTURING	9

Robotic welding, spray painting, cutting, and material handling applications; Robotic assembly and disassembly processes; Quality control and inspection using robotic systems.

UNIT III	ROBOTS FOR INSPECTION	9

Robotic vision systems, image representation, object recognition and categorization, depth measurement, image data compression, visual inspection, software considerations.

UNIT IV	ROBOTIC INTEGRATION AND AUTOMATION	9

Integration of robots with manufacturing equipment: CNC machines, conveyors, and production lines; pick and place, palletizing, depalletizing; machine loading and unloading; Human-robot collaboration (HRC) and safety considerations in manufacturing environments; Robotic centered cell.

UNIT V	ADVANCED TOPICS	9

Emerging technologies in robotics for smart manufacturing: AI, machine learning; predictive maintenance; robotic fleet management and decentralized control systems; case studies and real-world applications of robotics in smart manufacturing; simulation tools for robotics: Using software like Robot Studio, Gazebo, or ROS for virtual testing

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand various types of industrial robots; sensors and actuators used in robots.	2
CO2	Understand various applications of robots in manufacturing.	2
CO3	Understand the robotic vision system and how it is used for inspection	2
CO4	Understand the integration of robots with manufacturing equipment; human-robot collaboration.	2
CO5	Apply the emerging technologies like AI, ML in robotics; use software tools to simulate robot environment.	3

TEXTBOOKS:	
1.	"Industrial Robotics: Technology, Programming, and Applications" by Mikell P. Groover, Mitchel R. Weiss, Roger N. Nagel, and Nicholas G. Odrey.
2.	"Robotics: Modelling, Planning and Control" by Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, and Giuseppe Oriolo
3.	"Introduction to Autonomous Robots" by Nikolaus Correll, Jonathan C. How, and Vijay Kumar
REFERENCES:	
1.	Advanced Robotics and Intelligent Automation in Manufacturing. United States, IGI Global, 2019.
2.	Hunt, V.. Smart Robots: A Handbook of Intelligent Robotic Systems. Switzerland, Springer US, 2013.
3.	Robotics in Smart Manufacturing: International Workshop, WRSM 2013, Co-located with FAIM 2013, Porto, Portugal, June 26-28, 2013. Proceedings. Germany, Springer Berlin Heidelberg, 2013.
E-RESOURCES:	
1.	https://www.ieee-ras.org/educational-resources-outreach/educational-material-in-robotics-and-automation
2.	https://roboticscasual.com/robotics-tutorials/
3.	https://www.robots.com/applications

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3													1
2	1		3	2										3
3				2	1									1
4			2	2		1								2
5	3				3								3	2

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

MN22060	MINI PROJECT (Common to MN and ME)	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

1.	To apply the knowledge obtained through the courses in a vertical for carrying out a project work or laboratory exercises or relevant internship in industry.

PROJECT WORK:

GUIDELINES

1. The project can be carried out as an individual or group project. Maximum 4 members can be present in a group. Each project shall have a supervisor.
2. A particular domain / field shall be selected by the students in consultation with their supervisor.
3. The students shall be encouraged to attend a design thinking workshop / opportunity identification session / problem statement writing.
4. The device / system / component(s) to be fabricated, may be decided in consultation with the supervisor and if possible with an industry.
5. The students shall prepare time schedule to complete the project.
6. The progress of the fabrication / development of the device / system / component(s) shall be reviewed periodically by a committee.
7. The project work shall be evaluated based on oral presentation, demonstration of the working model and the project report jointly by external and internal examiners.

LABORATORY EXERCISES:

GUIDELINES:

1. Exercises (not less than 10 nos.) should be framed to reflect the courses in the vertical and can be performed in applicable laboratories.
2. A Record of exercises shall be maintained by the student and duly verified and evaluated by the teacher (s).

INTERNSHIP:

GUIDELINES:

1. Students shall undergo Industrial training / Internship for a period of 4 weeks to earn 2 credits.
2. The students may undergo Internship at Industry / Research organization / University (after due approval from the Department Consultative Committee) for the period prescribed.
3. At the end of the internship, the student shall submit a report to the committee for evaluation.

TOTAL: 60PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Apply the concepts learnt in the vertical and develop a process / working model or perform related laboratory exercises or take up internship in related industries and complete it successfully	3

VERTICAL 7
DIVERSIFIED GROUP 1

MN22071	COMPUTATIONAL FLUID DYNAMICS: THEORY AND PRACTICES	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

1.	To teach the fundamental principles of fluid dynamics and governing equations, including conservation of mass, momentum, and energy.
2.	To understand the concepts of numerical methods such as finite difference and finite volume techniques for solving fluid flow problems.
3.	To enhance the skills in computational fluid dynamics (CFD) simulations using software tools like ANSYS Fluent and CFX, including mesh generation and analysis of flow phenomena.

UNIT I	INTRODUCTION AND GOVERNING EQUATIONS	10

Introduction –Conservation equation - Governing equations of fluid dynamics – Continuity - Momentum and energy –Convective forms of the equations - Initial and Boundary conditions - Governing equations for boundary layers - Classification of partial differential equations – Hyperbolic - Parabolic - Elliptic and Mixed types - Applications and relevance.

UNIT II	INTRODUCTION IN FINITE DIFFERENCE AND FINITE VOLUME METHODS	10

Simple Methods – General Methods for first and second order accuracy – solution methods for finite difference equations – Elliptic equations – Iterative solution Methods – Parabolic equations – Explicit and Implicit schemes.

Finite volume formulation for steady state one and two -dimensional diffusion problems. One dimensional unsteady heat conduction through Explicit, Crank – Nicolson and fully implicit schemes.

UNIT III	CALCULATION FLOW FIELD BY FINITE VOLUME METHOD	10

Special Features of Navier-Stokes Equations - Time Integration Techniques for Navier-Stokes Equations - Implicit Pressure Correction Methods - SIMPLEC, SIMPLER and Fractional Step Methods

Turbulence modeling: Reynolds averaged Navier-Stokes equations, RANS modeling, DNS and LES.

LABORATORY COMPONENT

LIST OF EXPERIMENTS (Any SIX)

1.	Introduction to ANSYS Fluent and CFX – Geometry creation, Mesh generation techniques
2.	Flow inside a bent pipe – Velocity and Pressure profile
3.	Laminar flow simulation in a stepdown chamber
4.	External flow over an airfoil – drag force and lift force plots
5.	External flow over a 2D/3D car – Transient Analysis
6.	Simulation of flow in a convergent divergent nozzle- Velocity and Pressure profile under sub-sonic and super-sonic conditions
7.	Simulation and Heat transfer analysis in a heat exchanger
8.	HVAC simulation using CFX
9.	Multiphase flow analysis in Cyclone
10.	Simulation of wind turbine (2 blades or 3 blades)

TOTAL: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Apply conservation equations to describe fluid flow and heat transfer phenomena, with the ability to classify partial differential equations into hyperbolic, parabolic, elliptic, and mixed types.	3
CO2	Implement finite difference and finite volume methods for solving steady-state and unsteady fluid flow problems, including iterative solution techniques for elliptic and parabolic equations.	3
CO3	Perform simulations of complex flow scenarios, such as turbulence modeling using Reynolds-averaged Navier-Stokes (RANS) equations, and understand the implications of different turbulence models like DNS and LES.	4
CO4	Demonstrate proficiency in using ANSYS Fluent and CFX software for simulating various flow scenarios, including internal and external flows, heat transfer analysis, and multiphase flow simulations.	4

TEXTBOOKS:

1.	H.K. Versteeg, W. Malalasekera, "An Introduction to Computational Fluid Dynamics, The Finite Volume Method", Pearson Publication, 2011
2.	Jiyuan Tu, Guan Heng Yeoh, Chaoqun Liu, "Computational Fluid Dynamics: A Practical Approach",Elsevier Science, 2012

REFERENCES:

1.	Anderson. J.D, "Computational Fluid Dynamics- The Basic with Applications", Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2004
2.	Chung T.J, "Computational Fluid Dynamics", Cambridge University Press, 2003
3.	Clovis R. Maliska, "Fundamentals of Computational Fluid Dynamics: The Finite Volume Method", Springer International Publishing, 2023

E-RESOURCES:

1.	https://nptel.ac.in/courses/112105045
2.	https://archive.nptel.ac.in/courses/112/105/112105254/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3		2								2	
2	3	3	3		2								2	
3	3	2	2		3								2	
4	2	2	2		3				2			2	2	

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS		
SL.No.	**ITEM DESCRIPTION**	**Qty.**
HARDWARE		
1.	Computer Server	1
2.	Computer nodes or systems (High end CPU with atleast 1 GB main memory) networked to the server	30
3.	Laser Printer	1
SOFTWARE		
4.	CFD Software	30
5.	Licensed operating system	Adequate

AE22602	HYBRID AND ELECTRIC VEHICLES (Common to AE, ME and MN)	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

1.	To make the students to know and understand the constructional and working details about Hybrid and Electric Vehicles.
2.	To introduce various configuration of Hybrid and Electric Vehicles.
3.	To impart the knowledge about energy storage devices.
4.	To impart knowledge on electrical drives for automobiles.
5.	To introduce various electronic controllers for Hybrid and Electric Vehicles.

UNIT I	INTRODUCTION TO NEED FOR ALTERNATIVE SYSTEM	9

History of electric and hybrid vehicles. Need of electric and hybrid vehicles – comparative study of diesel, petrol, electric and hybrid vehicles, Limitations of electric vehicles, Specification of different electric and hybrid vehicles. Opportunities and challenges in electric and hybrid vehicles.

UNIT II	ENERGY STORAGE DEVICES	9

Electrochemical batteries, types of batteries – lead acid batteries, nickel based batteries, lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency and ultra-capacitors. Recent developments in the Battery charging – Charging Methodologies - Charging stations - Battery swapping.

UNIT III	ELECTRIC VEHICLES	9

Electric vehicle layout, performance of electric vehicles, traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, system components, electronic control system, advantage and limitations, safety and challenges, Case study of latest electric vehicles.

UNIT IV	HYBRID VEHICLES	9

Concepts of hybrid electric drive train, types, architecture of series and parallel hybrid electric drive train, merits and demerits, hybrid electric drive train design, mild and full hybrids, Plug-in hybrid electric vehicles and range extended hybrid electric vehicles, Case study of latest Hybrid vehicles.

UNIT V	PROPULSION MOTORS AND CONTROLLERS	9

Types of electric motors – working principle of AC and DC motors, Characteristic of shunt, series and compound, types of DC motors - permanent magnet and separately exited DC motors, AC single phase and 3-phase motor, inverters, DC and AC motor speed controllers. Selection of motors and controllers.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Outline the need and history of alternative systems for vehicle propulsion and compare their performance with conventional vehicles.	3
CO2	Discuss and compare the construction, working and performance of various energy storage devices and their construction methodologies.	3
CO3	Discuss and compare the architecture, performance of electric vehicles and their safety aspects.	3

CO4	Classify and discuss the different hybrid vehicle architecture and study their merits and demerits.	3
CO5	Describe the working, characteristics of propulsion motors and speed controllers.	3

TEXTBOOKS:	
1.	Iqbal Husain, "Electric and Hybrid Vehicles Design Fundamentals", CRC Press, 2005.
2.	Mehrdad Ehsani, Yimin Gao, Stefano Longo, Kambiz Ebrahimi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", Third Edition, CRC Press, 2018.
REFERENCES:	
1.	Ron HodKinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication, 2005.
2.	Ronald K. Jurgen, "Electric and Hybrid-Electric Vehicles: Engines and Powertrains", SAE International, 2015.
3.	Tom Denton, "Electric and Hybrid Vehicles", 1st edition, Routledge Publishers, 2017.
4.	Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles", Softcover reprint of the original 1st ed, Springer, 2013.
E-RESOURCES: (including NPTEL course)	
1.	https://onlinecourses.nptel.ac.in/noc24_ee30/preview
2.	https://onlinecourses.nptel.ac.in/noc22_ee53/preview
3.	https://nptel.ac.in/courses/108106170

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1.	3	2										2	1	
2.	3	2										2	1	
3.	3	2										2	2	
4.	3	2										2	2	
5.	3	2										2	2	

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

MN22072	NANOTECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	Explore the evolution of Nanotechnology in various fields of engineering.
2.	Learn the details of clean room environment and safety hazards.
3.	Understand the growth techniques of nano materials and nanofabrication techniques.
4.	Investigate different characterization techniques used for nano systems

UNIT I	INTRODUCTION TO NANOTECHNOLOGY	6

Nanoscale Science and Technology – Background, definition and applications – Crystal bonding, structure and growth – Size and dimensionality effects – Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials – Classifications of nanomaterials based on dimensionality. Properties and applications of Carbon Nanotubes.

UNIT II	SEMICONDUCTOR PROCESSING AND MICROFABRICATION	6

Introduction to semiconductor processing – Necessity for a clean room – different types of clean rooms – Structure and requirements of a clean room – Safety issues, flammable and toxic hazards, biohazards – Micro fabrication process – Etching techniques.

UNIT III	GROWTH TECHNIQUES OF NANOMATERIALS	12

Top-Down and Bottom-Up approaches – Vacuum based deposition processes: Plasma Arc Discharge, Sputtering, Evaporation, Chemical Vapour Deposition, Pulsed Laser Deposition, Molecular Beam Epitaxy – Solution based deposition processes: Sol-Gel Technique, Electro deposition – Other processes: Mechanical Ball milling, Chemical Bath Deposition, Ion Beam Deposition, Vapour-Liquid-Solid method.

UNIT IV	CHARACTERIZATION TECHNIQUES	12

Optical Microscopy: Confocal Microscopy – X-Ray Diffraction (XRD) technique – Scanning Probe Microscopy (SPM): Scanning Tunneling Microscopy (STM) – Atomic Force Microscope (AFM) – Electron Microscopy (EM): Resolution and Magnification, Scanning Electron Microscope (SEM) Technique, Principal elements of SEM, Specimen Interactions, Environmental SEM (ESEM), Transmission Electron Microscope (TEM), High Resolution TEM (HRTEM).

UNIT V	APPLICATIONS	9

Nano biology: Nano probes for analytical applications in medical diagnosis and biotechnology, Nanoparticles for targeted drug delivery – Nano biosensors: real-time imaging in biological events, smart dust – Nano medicines – Nano tribology: Super lubricity, Nano lubrication, Nano fluids – Micro Electro Mechanical Systems (MEMS).

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand unique properties of Nano material structure and apply them into different engineering fields.	3
CO2	Work in a safe environment by following necessary safety protocol in nano-fabrication cleanroom.	3

CO3	Synthesis different types of nanomaterials using various top-down and bottom up approach.	4
CO4	Characterize different types of nano-particles using electrical, optical and structural methods	4
CO5	Comprehend varied applications of nanotechnology in sub-micron and nano-scale range.	3

TEXTBOOKS:

1.	K. K. Chattopadhyay and A. N Banerjee, Introduction to Nanoscience and Nanotechnology, PHI, 2009.
2.	T. Pradeep, Nano: The Essentials, McGraw Hill Education, 2007.

REFERENCES:

1.	T. Pradeep, A Textbook of Nanoscience and Nanotechnology, Tata McGraw Hill Education, 2012.
2.	Charles P.Poole Jr and Frank ,J. Owens, Introduction to Nanotechnology, Wiley India, 2006.
3.	W. R. Fahrner, Nanotechnology and Nanoelectronics, Springer (India) Private Ltd., 2005.

E-RESOURCES:

1.	https://onlinecourses.nptel.ac.in/noc24_me20/preview
2.	https://onlinecourses.swayam2.ac.in/cec24_cy03/preview

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3						2	3			1	
2	3	3	3		3	3		3	2	3			1	
3	3	3	3	3	3			3	2	3		2	1	
4	3	3	3	3	3			3	2	3		2	1	
5	2	3	3	3			3	3	2	3		2	1	

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

MN22073	NON-DESTRUCTIVE TESTING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	Understand the need of non-destructive testing.
2.	Explore the various non-destructive testing methods to evaluate the defects on the surface.
3.	Learn the various non-destructive techniques, involving thermal energy, electro-magnetic theory, high energy radiation and sound waves.

UNIT I	OVERVIEW OF NDT	6

Definition, need, types and benefits of non-destructive testing, steps involved in NDT – destructive vs non-destructive testing – Manufacturing processes and defects in materials – Visual inspection: principle, unaided visual inspection, detection of defects by optical aids.

UNIT II	NDT FOR SURFACE DEFECTS	10

Liquid Penetrant Testing (LPT) – physical principle, procedure for LPT, penetrant testing material, LPT methods, applications and limitations, standards, case studies for interpretation and evaluation. Magnetic Particle Testing (MPT) – definition of magnetism, principle of MPT, magnetizing techniques, procedure and equipment used for MPT, applications and limitations, demagnetization – case studies for interpretation and evaluation.

UNIT III	THERMOGRAPHY AND EDDY CURRENT TESTING (ECT)	10

Thermography – basic principle, detectors and equipment for thermography test, thermography techniques, applications, examples on thermo gram, thermal imaging. Eddy Current Testing (ECT) – Principles – Instrumentation for ECT – ECT techniques – applications and limitations – Case studies for interpretation and evaluation.

UNIT IV	RADIOGRAPHY	9

Principle – X-ray source, production and properties – radiation attenuation in the specimen – effect of radiation on film – Radiographic imaging and inspection techniques – applications and limitations – safety aspects in radiographic testing – Case studies for interpretation and evaluation.

UNIT V	ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION TESTING (AET)	10

Ultrasonic Testing – introduction – frequency, generation and types of ultrasonic waves – Transducers – reflection, refraction and scattering of ultrasonic beams – Ultrasonic Testing techniques: Pulse-echo technique and through transmission technique – normal beam and angle beam inspection – Ultrasonic Flaw detector – Types of scan for interpretation – A-scan, B-scan and C-scan – application and limitations. Acoustic Emission Technique – Principle, AET parameters, Instrumentation, applications – Case studies.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand the defects occurred on manufactured parts and need of NDTs	2
CO2	Identify the appropriate NDT method such as liquid penetrant, magnetic particle testing to analysis the possible surface defects.	3

CO3	Identify the nature of manufactured parts and use thermography or eddy current techniques for analysing the defects aroused on the parts manufactured.	4
CO4	Examine the internal defects occurred in the parts manufactured by welding, forging, casting, etc. by applying radiography methods.	4
CO5	Examine the structural integrity on the fabricated parts by applying AE method.	3

TEXTBOOKS:

1.	Baldev Raj, T. Jayakumar, M. Thavasimuthu, Practical Non-Destructive Testing, Narosa Publishing House, 2009.
2.	Ravi Prakash, Non-Destructive Testing Techniques, New Age International Publishers, 2010

REFERENCES:

1.	J Prasad and C G K Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw Hill Education, 2011.
2.	Paul E Mix, Introduction to Nondestructive Testing: A Training guide, Wiley, 2005.
3.	ASM Handbook, Nondestructive Evaluation of Materials, Volume 17, ASM International, 2018.
4.	Charles J. Hellier, Handbook of Nondestructive Evaluation, McGraw Hill, 2020.
5.	ASNT (The American Society for Nondestructive Testing, Columbus, Ohio) NDT Handbook, Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing.

E-RESOURCES:

1.	https://onlinecourses.nptel.ac.in/noc24_mm14/preview
2.	https://www.nde-ed.org/

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	1												2	
2	3	2		3	3	1					1	1	2	
3	3	2		3	3	1					1	1	2	
4	3	2	2	3	3	1					1	1	2	
5	3	2		3	3	1					1	1	2	

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

MN22074	PRODUCTION PLANNING AND CONTROL (Common to MN and ME)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To impart knowledge about objectives, functions, significance of PPC
2.	To examine several classic Operations Management planning topics including forecasting and inventory control.
3.	To develop skills in scheduling and line balancing in production.

UNIT I	INTRODUCTION TO PRODUCTION PLANNING AND CONTROL	9

Definition – Objectives of production Planning and Control – Functions of production planning and control – Elements of production control – Types of production – Organization of production planning and control department - Profit consideration- Standardization, Simplification & specialization- Break even analysis-Economics of a new design.

UNIT II	FORECASTING	8

Importance of forecasting –Types of forecasting, their uses –General principles of Forecasting – Forecasting techniques- qualitative methods and quantitative methods.

UNIT III	INVENTORY MANAGEMENT	9

Functions of inventories – relevant inventory costs – ABC analysis – VED analysis – EOQ model: Simple problems – Inventory control systems – P–Systems and Q-Systems - MRP-I, MRP-II & ERP, Kanban system.

UNIT IV	SCHEDULING	10

Definition – Activities-Difference with loading, Scheduling types: Forward, Backward scheduling, Job shop scheduling methods – Arrival pattern, processing pattern, number of workers available, machine varieties available, Priority rules for job sequencing FIFO, SPT, SOT, EDD, STR, CR, LISO, Random Orders. Scheduling Techniques Gantt Charts, LOB, Johnson's job sequencing rules- n jobs on 2machines, n jobs on 3 machines, n jobs on m machines: Simple problems.

UNIT V	LINE BALANCING	9

Aggregate planning, Chase planning, Expediting, controlling aspects. Dispatching – Activities of dispatcher – Dispatching procedure – follow-up – definition – Reason for existence of functions – types of follow-up, applications of computer in production planning and control.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Understand the problems and opportunities faced by the operations manager in manufacturing and service organizations	2
CO2	Summarize forecasting techniques used in industries with their relevant applications	3
CO3	Analyse inventory control using inventory management techniques	3
CO4	Develop an ability to apply scheduling concepts in various areas like marketing, engineering, personnel management, logistics, etc.	3
CO5	Apply line balancing concepts in Production planning environments	3

TEXTBOOKS:

1.	Samuel Eilon, “Elements of Production Planning and Control”, Universal Publishing Corporation, Digitized 2007
2.	Baffa & Rakesh Sarin, “Modern Production & Operations management”, 8th edition, John Wiley,2007

REFERENCES:

1.	S.N. Chary, “Production & Operations Management”, (6th Edition), TMH.2019
2.	Martin K. Starr and David W. Miller, “Inventory Control Theory and Practice”, Prentice Hall,1962
3.	R.Paneerselvam, “Production and Operations Management”, Third Edition, PHI learning Private Limited,2012
4.	William Stevenson, “Operations Management", (14th Edition), McGraw-Hill Education,2020

E-RESOURCES: (including NPTEL course)

1.	https://archive.nptel.ac.in/courses/110/107/110107141/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1.	2	2									1		1	2
2.	2	2									2		1	2
3.	2						2						2	2
4.	2						2				2		2	2
5.	1				2		2				2		2	2

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

MN22075	SMART AND BIOMATERIALS (Common to MN and ME)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To comprehensively understand the performance characteristics, manufacturing processes, and applications of various biomaterials, including metallic, ceramic, and polymeric materials.
2.	To comprehensively explore the properties, manufacturing processes, and applications of shape memory alloys (SMAs), including metallic alloys exhibiting shape memory effects, and investigate the advantages, challenges, and diverse applications of smart composites incorporating SMAs.

UNIT I	Biomaterials	10

Introduction To Bio Materials – Historical Background – Performance Of Biomaterials – Metallic Biomaterials – Stainless Steel, Ti Alloys, CoCr Alloys, Tini Alloys, Dental Metals – Corrosion Of Available Metals – Rate Of Corrosion – Manufacturing Of Implants - Ceramic Biomaterials – Alumina – Zirconia – Carbon – Biodegradable Ceramics – Calcium Phosphate – Al-Calcium Phosphate Ceramics – Polymeric Biomaterials – Effect Of Structural Modification And Properties - Polyvinylchloride – Polyethylene -Polyesters-Polyamides – Biomaterials For Bone Tissue Engineering Applications - Dental Implants – Effect of Material Selection – Effect of Surface Properties

UNIT II	Dynamics of smart materials	9

Smart Materials – Features – Applications - Scale Of Intelligence – Active Smartness – Traditional Vs Smart Systems - Smart Materials As Sensors And Actuators – Direct And Converse Effect - Properties Of Smart Materials – Piezoelectric Materials - Preparation Of Piezoceramic Actuators – Piezoelectric Polymers And Composites - Applications – Magneto Strictive Materials – Effects Of Magnetostriction Electro active Polymers – Classifications – Applications

UNIT III	Shape memory alloys and smart composites	9

Shape Memory Alloys - Metallic Alloys – Shape Memory Effects – Manufacturing Of SMA Wires – Crystal Structures Of SMA – Low Temperature Stress – Strain Behaviour – Hysteresis Curve Of SMA – Pseudo elasticity – One Way And Two Way Shape Memory Effect - Applications – SMA Based Sensor - Smart Composites – Advantages - Issues – Applications

UNIT IV	Processing of smart materials	9

Introduction – Semiconductors and Their Processing – Metallization Techniques – Ceramics – Fabrication Of Thick And Thin Films – Silicon Micromachining Techniques – Polymers And Their Synthesis – UV Radiation Curing Of Polymers – Deposition Techniques For Polymer Thin Films - Integration And Packaging Of Smart Microsystems

UNIT V	Applications of Active Materials in Integrated Systems	8

Solid State Actuation And Stroke Amplification – Active Fiber Composites – Amplification By External Leverage Mechanisms – Torsional Actuators – Double Lever Actuators - Tuning Of Composite Beams - Shunted Piezoelectrics - Energy Harvesting - Vibration And Noise-Control Applications

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Analyze the performance characteristics, manufacturing techniques, and wide-ranging applications of metallic, ceramic, and polymeric biomaterials.	4
CO2	Analyze the features, properties, and applications of smart materials.	4
CO3	Understand the characteristics of shape memory alloys and select SMA-based sensors and smart composites for the given engineering applications.	3
CO4	Apply semiconductor processing, metallization techniques, ceramics fabrication, polymer synthesis, micromachining, UV radiation curing, deposition techniques for polymer thin films, and integration/packaging of smart microsystems to solve real-world engineering problems effectively.	3
CO5	Apply active materials in integrated systems for engineering applications	3

TEXTBOOKS:

1.	Joyce Y. Wong, Joesph D. Bronzino, "Biomaterials", CRC Press, 2007
2.	Vijay K. Varadan, K. J. Vinoy and S. Gopalakrishnan, "Smart Material Systems and MEMS: Design and Development Methodologies", 2006
3.	Inderjit chopra, Jayant Siroji, Smart structures theory, Cambridge university press, 2013

REFERENCES:

1.	Mel Schwartz, "Smart Materials", CRC Press, 2009
2.	Mel Schwartz, "Encyclopedia of Smart Materials", Volume 1 and Volume 2, John Wiley & Sons, 2002
3.	Dr.P. Nikhil Chandra, Dr. Mothi Krishna Mohan, "Smart Materials", Notion press, 2021

E-RESOURCES: (including NPTEL course)

1.	http://acl.digimat.in/nptel/courses/video/113104009/L01.html
2.	http://acl.digimat.in/nptel/courses/video/113108071/L01.html
3.	https://nptel.ac.in/courses/112104173
4.	https://archive.nptel.ac.in/courses/112/104/112104203/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1.	3	3				1			1	1		1	3	3
2.	3	3				1			1	1		1	3	3
3.	3					1			1	1		1	3	3
4.	3					1			1	1		1	3	3
5.	3					1			1	1		1	3	3

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

MN22076	WELDING TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Understand the physical principles of welding process
2. Learn the various types of welding processes.
3. Explore the possibilities of welding automation.

UNIT I	GAS AND ARC WELDING PROCESSES	10

Gas welding: Principle – Gas welding equipment – Oxy-acetylene welding – Air-acetylene welding – Arc welding: Carbon-arc welding, Shielded-metal arc welding, Submerged arc welding, TIG & MIG welding, Electroslag welding and Plasma arc welding processes – principle, equipment, operation, advantages, limitations and applications.

UNIT II	RESISTANCE WELDING PROCESSES	10

Electric resistance welding – fundamentals, process variables, advantages, limitations and application – Spot welding, Seam welding, Projection welding, Resistance Butt welding, Flash Butt welding, Percussion welding and High frequency resistance welding processes – advantages, limitations and applications.

UNIT III	SOLID STATE AND OTHER WELDING PROCESSES	10

Cold (pressure) welding, Diffusion (bonding) welding, Ultrasonic welding, Explosive welding, Friction welding, Forge welding – Thermit welding, Atomic hydrogen welding, Electron beam welding, Laser Beam welding, Under Water welding – advantages, limitations and applications.

UNIT IV	WELDING ENGINEERING	9

Types of Joints and Welds – basic welding symbol – Weldability of specific materials: Aluminium, Copper, and Stainless steels – Weld defects – Welding Test: Tensile test, radiography test, liquid penetrant test, ultrasonic testing.

UNIT V	WELDING AUTOMATION	6

Computer aided welding – Software for welding engineers – Robotic welding system – types of welding robots – control system of welding robot – Classes and levels in welding automation – Applications.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand the principles of Gas and Arc welding to fabricate the automotive assembly units	2
CO2	Applying the resistance welding method for industrial components fabrication.	3
CO3	Select the appropriate welding technology for welding of precision engineered parts in specifics industrial applications.	3
CO4	Analyse the welded parts by applying appropriate testing methods.	4
CO5	Acquire knowledge on welding automation for various industrial applications.	2

TEXTBOOKS:	
1.	O. P. Khanna, A Textbook of Welding Technology, Dhanpat Rai Publications, 1999.
2.	Dr. R. S. Parmar, Welding Engineering and Technology, Khanna Publishers, 2015.
REFERENCES:	
1.	J. F. Lancaster, The Physics of Welding, Pergamon, 1986.
2.	V. M. Radhakrishnan, Welding Technology and Design, New age. 2002.
E-RESOURCES:	
1.	https://onlinecourses.nptel.ac.in/noc24_mm15/preview
2.	https://onlinecourses.nptel.ac.in/noc24_me33/preview

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	1			2				1		1			3
2	3	1			2				1		1			3
3	3	1			3				1		1			3
4	3	3		3	3				1	2	1			
5	3				3				3	2	2	2		3

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

MN22077	INTRODUCTION TO HEAT TRANSFER	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES:

1.	To teach one-, two- and three-dimensional heat conduction in steady and transient state in general and 1D steady state and Lumped system in transient state in particular.
2.	To teach the fundamentals of forced and natural convection and the method to calculate the heat transfer coefficients using the analytical method and more emphasize is on how to make use of proposed correlations for the analysis of forced and natural convection in various practical applications. Numerical analysis is not the scope of this subject.
3.	To teach the physics of boiling and Condensation and their associated correlations to calculate the boiling and condensation heat transfer, however, forced convective boiling and drop wise condensation are to be treated qualitatively.
4.	To teach how to analyse the various types of heat exchanger both for designing and rating.
5.	To teach the fundamentals of radiation and how to calculate the radiation heat transfer between the real surfaces.
6.	To teach the basic concepts of Mass transfer and the calculation of diffusive and Convective mass transfer using correlations.

UNIT I CONDUCTION **9**

General three-dimensional heat conduction equation in cartesian, cylindrical and spherical coordinates – Analysis of 1D steady state in all three coordinates for single and composite systems without heat generation – 1D Extended surfaces – Transient heat conduction – lumped system analysis only. Semi Infinite and Infinite Solids –Use of Heisler's charts.

UNIT II CONVECTION **9**

The Convection Boundary Layers - Local and Average Convection Coefficients - Laminar and Turbulent Flow - Physical Interpretation of the Dimensionless Parameters - Boundary Layer Analogies External Flow - Internal Flow. Free Convection - Physical Considerations - The Governing Equations for Laminar Boundary Layers - Similarity Considerations - Laminar Free Convection on a Vertical Surface - Empirical Correlations: External Free Convection Flows - Empirical Correlations.

UNIT III BOILING AND CONDENASATION HEAT TRANSFER **9**

Dimensionless Parameters in Boiling and Condensation - Boiling Modes - Pool Boiling - Pool Boiling Correlations - Forced Convection Boiling - Condensation: Physical Mechanisms - Laminar Film Condensation on a Vertical Plate Turbulent Film Condensation - Condensation in Horizontal Tubes Dropwise Condensation (Qualitative treatment only)

UNIT IV HEAT EXCHANGERS **9**

Heat Exchanger Types – TEMA standard -The Overall Heat Transfer Coefficient – Fouling factors - Heat Exchanger Analysis: Use of the Log Mean Temperature Difference and The Effectiveness–NTU Method – Introduction to Compact and special type of heat exchangers (Qualitative treatment only)

UNIT V RADIATION HEAT TRANSFER **9**

Fundamental Concepts - Radiation Heat Fluxes - Radiation Intensity - Blackbody Radiation - Emission from Real Surfaces - Absorption, Reflection, and Transmission by Real Surfaces - Kirchhoff's Law - The Gray Surface – Electrical analogy – Radiation shields – Gas Radiation.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Calculate the following (i) one dimensional steady state heat transfer (ii) one dimensional steady state heat transfer in extended surfaces (iii) transient heat transfer using lumped parameter analysis.	3
CO2	Understand the complexity involved in the analytical solution of Convective heat transfer and hence identify the required correlations to calculate the convective heat transfer for the given practical applications.	3
CO3	Students will be able to analyse the heat exchangers using LMTD method and Ɛ – NTU method. They also will be able to calculate the boiling and Condensation heat transfer	3
CO4	Students will be able to calculate the radiation heat transfer between real surfaces and also between a surface and a gas (CO2 and H2O)	3
CO5	Students will be able to calculate the rate of mass transfer using diffusive and convective mass transfer equations and available correlations.	3

TEXTBOOKS:

1.	Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley & Sons, 7th Edition, 2014.
2.	Yunus A. Cengel, "Heat Transfer A Practical Approach" – Tata McGraw Hill, 5thEdition – 2013.

REFERENCES:

1.	Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, 2010.
2.	Ozisik, M.N., "Heat Transfer", McGraw Hill Book Co., 1994.
3.	Nag P. K., "Heat and Mass transfer", McGraw Hill education., 2011.

E-RESOURCES:

1.	https://onlinecourses.nptel.ac.in/noc24_ch17/preview
2.	https://www.udemy.com/share/103vKa/
3.	https://engineering.purdue.edu/online/courses/intermediate-heat-transfer
4.	https://ocw.mit.edu/courses/2-51-intermediate-heat-and-mass-transfer-fall-2008/
5.	https://www.classcentral.com/course/swayam-heat-transfer-10061

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1.	3	3	3	2									1	
2.	3	3	3	2									1	
3.	3	3	3	2									1	
4.	3	3	3	2									1	
5.	3	3	3	2										

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

VERTICAL 8

DIVERSIFIED GROUP 2

(Common to ME and MN)

ME 22081	AUTOMOBILE ENGINEERING (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To study the construction and working principle of various parts of an automobile.
2.	To study the practice for assembling and dismantling of engine parts and transmission system.
3.	To study various transmission systems of automobile.
4.	To study about steering, brakes, and suspension systems.
5.	To study alternative energy sources.

UNIT I	VEHICLE STRUCTURE AND ENGINES	9

Types of automobiles, vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics (various resistances and moments involved), IC Engine components – functions, materials and its applications in land (Off road and On road), variable valve timing (VVT) and its necessity.

UNIT II	ENGINE AUXILIARY SYSTEMS	9

Electronically controlled gasoline injection system for SI engines (SPI, MPFI, GDI), electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system CRDI), Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Turbo chargers (WGT, VGT), Engine emission control by three-way catalytic converter system, Emission Norms (Euro & BS).

UNIT III	TRANSMISSION SYSTEMS	9

Clutch-types and construction, gear boxes-manual and automatic, gear shift mechanisms, Over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

UNIT IV	STEERING, BRAKES AND SUSPENSION SYSTEMS	9

Steering geometry and types of steering gear box - Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS), electronic brake force distribution (EBD) and Traction Control.

UNIT V	ALTERNATIVE ENERGY SOURCES	9

Use of Natural Gas, Liquefied Petroleum Gas, Biodiesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles Engine modifications required – Performance, Combustion and Emission Characteristics of SI and CI engines with these alternate fuels - Electric and Hybrid Vehicles, Fuel Cell.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Classify the automobiles, their construction and working of various auxiliary systems.	2

CO2	Determine the various electronics components involved in automobile working system.	3
CO3	Understand the working of different types of transmission systems.	2
CO4	Understand the working of Steering, Brakes and Suspension Systems.	2
CO5	Identify possible alternate sources of energy for IC Engines.	3

TEXTBOOKS:

1.	Jain.K.K and Asthana R.B, "Automobile Engineering" Tata-McGraw Hill Publishers, New Delhi, 2002.
2.	Kirpal Singh, "Automobile Engineering", Vol.1&2, Thirteenth Edition (2014), Standard Publishers, New Delhi, 2018.

REFERENCES:

1.	Ganesan .V. "Internal Combustion Engines", Third Edition ,Tata-McGraw Hill, 2007.
2.	Heinz Heisler, "Advanced Engine Technology", SAE International Publications USA, 1998.
3.	Joseph Heitner, "Automotive Mechanics," Second Edition, East-West Press, 1999.
4.	Martin W, Stockel and Martin T Stockel , "Automotive Mechanics Fundamentals," The Good heart–Will Cox Company Inc, USA ,1978.
5.	Newton, Steeds and Garet, "Motor Vehicles", Butterworth Publishers, 1989.

E-RESOURCES:

1.	https://nptel.ac.in/courses/107/106/107106088/
2.	https://www.asdc.org.in

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2	2	2										3	
2	2	2	2										3	
3	2	2	2										3	
4	2	2	2										3	
5	2	2	2										3	

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

ME22082	COMPOSITE MATERIALS AND MECHANICS (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To know the importance of composite materials in various industry applications,
2.	To understanding and identifying the suitable manufacturing methods for making different composite materials.
3.	To impart the micromechanics of lamina, the macromechanics of laminates.
4.	To acquire the knowledge on fracture mechanics and design of laminates.

UNIT I	INTRODUCTION TO COMPOSITE MATERIALS	9

Introduction to Composite Materials, classification of composite materials, Matrices and Reinforcement, Types of Fiber Reinforcement, Types of matrix materials- Thermoset and Thermoplastic, Advantages and Disadvantages, Applications of composite materials, Mechanics Terminology.
Special cases of Laminates; Symmetric Laminates, Cross-ply laminates, Angle ply Laminates, antisymmetric Laminates, Balanced Laminate. Failure Criterion for a Laminate. Design of a Laminated Composite.

UNIT II	MANUFACTURING TECHNIQUES OF COMPOSITES	9

Layup and curing, fabricating process, open and closed mould process, Hand layup techniques; structural laminate bag molding, production procedures for bag molding; filament winding, pultrusion, pulforming, thermo-forming, injection molding, blow molding. Manufacturing methods for Metal Matrix Composites (MMC's): Powder metallurgy technique, liquid metallurgy technique, special fabrication techniques.

UNIT III	MICROMECHANICS OF COMPOSITES	9

Density, Mechanical Properties; Prediction of Elastic Constants, Micromechanical Approach, Halpin-Tsai Equations, Transverse Stresses. Thermal Properties; Expression for Thermal Expansion Coefficients of Composites, Expression for Thermal Conductivity of Composites. Mechanics of Load Transfer from Matrix to Fiber; Load transfer in Particulate Composites.

UNIT IV	MACROMECHANICS OF COMPOSITES	9

Elastic Constants of an Isotropic Material, Elastic Constants of a Lamina, Relationship between Engineering Constants and Reduced Stiffnesses and Compliances, Variation of Lamina Properties with Orientation, Analysis of Laminated Composites, Stresses and Strains in Laminate Composites, Inter-laminar Stresses and Edge Effects.

UNIT V	STRENGTH AND FRACTURE OF COMPOSITES	9

Tensile and Compressive strength of Unidirectional Fiber Composites. Fracture Modes in Composites; Single and Multiple Fracture, Debonding, Fiber Pullout and Delamination Fracture. Failure Analysis and Design of Laminates: Tests for measuring interfacial strength - Physical and chemical properties.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Apply knowledge of composite materials, matrices, reinforcement, and laminate design principles.	3

CO2	Select appropriate manufacturing processes for both polymer and metallic matrix composites.	3
CO3	Analyze the mechanical and thermal properties of composites for understanding the mechanics.	3
CO4	Calculate the Elastic Constants of a Lamina and its variation with orientation, and understand inter-laminar stresses.	3
CO5	Understand the principles of failure analysis to differentiate the fracture modes in composites.	3

TEXTBOOKS:

1.	Mallick, P.K. and Newman.S., "Composite Materials Technology", Hanser Publishers, 2003.
2.	Robert M. Jones, "Mechanics of Composite Materials" (Materials Science & Engineering Series), Taylor & Francis, 2015.
3.	R F Gibson, "Principles of Composite Material Mechanics", CRC Press,4th Ed., 2016.
4.	Hyer M.W, "Stress Analysis of Fiber Reinforced Composite Materials", McGraw Hill, 1998.

REFERENCES:

1.	Jones and Ashby, "Engineering Materials 2: An Introduction to Microstructure & Processing", 4th ed., 2012.
2.	Isaac M. Daniel, Ori Isha, "Engineering Mechanics of Composite Materials", Oxford University Press, 2005.
3.	Krishnan K Chawla, "Composite Materials: Science and Engineering", International Edition, Springer, 2012.

E-RESOURCES:

1.	https://archive.nptel.ac.in/courses/112/104/112104229/
2.	https://archive.nptel.ac.in/courses/112/104/112104168/
3.	https://archive.nptel.ac.in/courses/112/103/112103308/
4.	https://archive.nptel.ac.in/courses/112/104/112104221/
5.	https://archive.nptel.ac.in/courses/101/106/101106038/
6.	https://archive.nptel.ac.in/courses/112/104/112104173/

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2		2			1			1			3	
2	3	2		2			1			1			3	
3	3	2		2						1			3	
4	3	2		2						1			3	
5	3	2		2						1			3	

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

ME 22083	HEATING, VENTILATION AND AIR CONDITIONING SYSTEMS (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To introduce the underlying principles of operations in different Refrigeration & Air conditioning systems and components.
2.	To provide knowledge on design aspects of Refrigeration & Air conditioning systems.
3.	To study the vapour absorption and air refrigeration systems.
4.	To learn the psychrometric properties and processes.
5.	To study the air conditioning systems and load estimation.

UNIT I	INTRODUCTION	7

Introduction to Refrigeration - Unit of Refrigeration and C.O.P.– Ideal cycles- Refrigerants Desirable properties – Classification – Nomenclatures.

UNIT II	VAPOUR COMPRESSION REFRIGERATION SYSTEM	10

Vapor compression cycle: p-h and T-s diagrams - deviations from theoretical cycle – subcooling and super heating- effects of condenser and evaporator pressure on COP- multipressure system - low temperature refrigeration - Cascade systems – problems. Equipment's: Type of Compressors, Condensers, Expansion devices, Evaporators.

UNIT III	OTHER REFRIGERATION SYSTEMS	10

Working principles of Vapor absorption systems and adsorption cooling systems – Steam jet refrigeration- Ejector refrigeration systems- Thermoelectric refrigeration- Air refrigeration - Magnetic Vortex and Pulse tube refrigeration systems.

UNIT IV	PSYCHROMETRIC PROPERTIES AND PROCESSES	9

Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature Thermodynamic wet bulb temperature, Psychrometric chart; Psychrometric of air-conditioning processes, mixing of air streams.

UNIT V	HVAC SYSTEMS AND LOAD ESTIMATION	9

Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load; Classifications, Layout of plants; Air distribution system; Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors, Actuators & Safety controls.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand the basic concepts of Refrigeration.	2
CO2	Understand the Vapor compression Refrigeration systems and to analyze the performance.	3

CO3	Understand the various types of Refrigeration systems.	2
CO4	Calculate the Psychometric properties and analyze the various psychometric processes.	3
CO5	Understand the concepts of HVAC and to analyze the performance.	3

TEXTBOOKS:

1.	Arora, C.P., "Refrigeration and Air Conditioning", 3rd edition, McGraw Hill, New Delhi, 2010.
2.	A Textbook of Refrigeration and Air-Conditioning by R.K. Rajput, 2013

REFERENCES:

1.	ASHRAE Handbook, Fundamentals, 2010
2.	JonesW.P., "Air conditioning engineering", 5th edition, Elsevier Butterworth-Heinemann, 2007
3.	Roy J. Dossat, "Principles of Refrigeration", 4th edition, Pearson Education Asia, 2009.
4.	Stoecker,W.F. and Jones J.W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi,1986.
5.	Textbook of Refrigeration And Air-Conditioning (M.E.) by R.S. Khurmi, 2019.

E-RESOURCES:

1.	https://nptel.ac.in/courses/112105129/
2.	https://www.brighthubengineering.com/hvac

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2	2	2	1									3	
2	2	2	2	1									3	
3	2	2	2	1									3	
4	2	2	2	1									3	
5	2	2	2	1									3	

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

ME22084	INDUSTRIAL SAFETY ENGINEERING (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	Evaluate safety audits to identify hazards, ensure compliance with regulations, and improve safety measures.
2.	Recognize specific safety considerations associated with each type of operation to mitigate risks effectively.
3.	Learn techniques for monitoring safety performance, analyzing data, and implementing management strategies to enhance safety culture and practices.

UNIT I	INTRODUCTION	9

Evaluation of modern safety concepts - Safety management functions - safety organization, safety department - safety committee, safety audit - performance measurements and motivation - employee participation in safety - safety and productivity.

UNIT II	OPERATIONAL SAFETY	9

Hot metal operation – safety in Cutting – safety in welding – safety in Boilers- Pressure vessels – Furnace (all types) - Heat treatment processes shops – electroplating – grinding – forming processes-rolling – forging - surface hardening – casting – Moulding – coiling. Operational safety (cold metal operation), Safety in Machine shop - Cold bending and chamfering of pipes- metal cutting - shot blasting, grinding, painting - power press and other machines.

UNIT III	SAFETY, HEALTH, WELFARE AND LAW	9

Features of Factory Act – explosive Act – boiler Act – ESI Act – workman's compensation Act – industrial hygiene – occupational safety – diseases prevention – ergonomics - Occupational diseases, stress, fatigue - Health, safety and the physical environment - History of legislations related to Safety-pressure vessel act-Indian boiler act - The environmental protection act - Electricity act - Explosive act.

UNIT IV	SAFETY PERFORMANCE MONITORING	9

Permanent total disabilities, permanent partial disabilities, temporary total disabilities -Calculation of accident indices, frequency rate, severity rate, frequency severity-incidence, incident rate, accident rate, safety "t" score, safety activity rate – problems.

UNIT V	SAFETY MANAGEMENT	9

Methods of promoting safe practice – Safety organization- OSHA – Safety controls. visible and latent hazards - human factors and safety - safety audit - Case study roll of management and roll of Govt. in industrial safety - safety analysis Industrial fatigue- role of industrial psychology- risk analysis - safety training - accident and near miss investigations- promotional measures to avoid accidents - human reliability - safety management characteristics-industrial safety policies and implementation.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand the safety audit committee and management functions. Also Evaluate the modern safety concepts, measurements and motivations.	2

CO2	Obtain knowledge on different types of operational safety in hot metal and cold metal working process.	2
CO3	Evaluate the performance of safety health and Welfare Act, also implementation Workman Compensation Act.	3
CO4	Examine the safety performance monitoring and evaluations of accident rate.	3
CO5	Analyze and implement management techniques for safe practice in an organization.	3

TEXTBOOKS:

1.	Deshmukh, Industrial Safety Management, Tata McGraw Hill, 2008
2.	Roy Asfatil C, David W Rieske, Industrial safety and Health Management, Prentice Hall, 2009.

REFERENCES:

1.	Joseph F. Gustin, Safety Management: A Guide for facility Management, The Fairmont Press, Inc., 2008.
2.	Krishnan N.V., "Safety in Industry", Jaico Publisher House, 1996.
3.	Nair P M C, Industrial safety and the law" Attam Publisher's, 1994.

E-RESOURCES:

1.	https://onlinecourses.nptel.ac.in/noc20_mg43/preview
2.	https://archive.nptel.ac.in/courses/110/105/110105094/

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3					1		1			2	2	3	
2	3					1		1	1		2	2	3	
3	2			2		1	2	3				2	3	
4	2			2		1	2	3				2	3	
5	2			2		1	2	3				2	3	

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

ME22085	INSTRUMENTATION AND CONTROL SYSTEMS (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	Comprehensive understanding of the fundamental principles underlying instrumentation and control systems.
2.	Develop the analytical and design skills in the field of instrumentation and control systems.
3.	Identify, diagnose, and solve problems encountered in industrial automation and process control settings.

UNIT I	PROCESS CONTROL	9

Process Modeling: hierarchies - Theoretical models - transfer function, state space models and time series models -Development of empirical models from process data - Feedback and feed forward control - cascade control - selective control loops - ratio control - feed forward and ratio control.

UNIT II	PROCESS INSTRUMENTAION	9

PID design and tuning - trouble shooting - tuning of multi loop - PID control systems - Decoupling control: strategies for reducing control loop interactions. Instrumentation for process monitoring: codes and standards - preparation of P&I diagrams.

UNIT III	MODERN INSTRUMENTAION	9

Model predictive control - Statistical process control - supervisory control - direct digital control, distributed control - PC based automation. Programmable logic controllers: organization, programming aspects, ladder programming, final control elements - SCADA in process automation.

UNIT IV	VIRTUAL INSTRUMENTAION	9

Virtual Instrumentation - review of virtual instrumentation - block diagram and architecture of virtual instrument - conventional instruments versus traditional instruments - data-flow techniques - graphical programming in data flow.

UNIT V	INTELLIGENT CONTROL	9

Artificial Neural Network (ANN) based control: Introduction to ANN - model reference control - internal model control - predictive control - indirect and direct adaptive controller design using neural network. Fuzzy logic based control: fuzzy controllers – preliminaries - Mamdani and Sugeno inference methods.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Explain the significance of process control in industrial applications and its role in optimizing process efficiency and safety.	2
CO2	Select appropriate instrumentation devices for specific process measurement requirements, taking into account environmental conditions and process characteristics.	3
CO3	Critique the advantages and limitations of modern instrumentation techniques compared to traditional methods, considering factors such as cost, complexity, and reliability.	3

CO4	Simulate the behavior of physical systems using virtual instrumentation software, validating control strategies and testing system performance under different conditions.	4
CO5	Evaluate the performance of intelligent control systems in terms of stability, robustness, and adaptability, comparing them to conventional control methods.	4

TEXTBOOKS:

1.	Dale E. Seborg, Duncan A. Mellichamp, Thomas F. Edgar and Francis J. Doyle "Process Dynamics and Control", John Wiley and Sons, 2010.
2.	Ernest O. Doebelin, "Measurement Systems Application and Design", McGraw Hill International Editions, 2006.
3.	Bose N. K. and Liang P., "Neural Network Fundamentals with Graphs, Algorithms and Applications", Tata McGraw-Hill, 2006.
4.	Klir G. J. and Folger T. A., "Fuzzy Sets, Uncertainty and Information", Prentice Hall of India, 2006.

REFERENCES:

1.	Johnson D Curtis, "Process Control Instrumentation Technology", Prentice Hall India, 2013.
2.	Robert Fuller, "Advances in Soft Computing, Introduction to Neuro Fuzzy Systems", Springer, 2000.
3.	Laxmidhar Behera and Indrani Kar, "Intelligent Systems and Control", Oxford University Press, 2009.
4.	Jeffrey Travis and Jim Kring, "LabVIEW for Everyone", Prentice Hall, 2007.

E-RESOURCES:

1.	https://nptel.ac.in/courses/103103037
2.	https://onlinecourses.nptel.ac.in/noc24_ee56/preview

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3										1	3	
2	3	2										1	3	
3	3	2										1	3	
4	3	2			2							1	3	
5	3	2			2							1	3	

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

ME 22086	POWER PLANT ENGINEERING (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To teach the concepts of coal based thermal power plants.
2.	To teach the principles of operations in diesel and gasifier system.
3.	To impart overall knowledge on different types of nuclear power plants,
4.	To teach the various renewable energy resources.
5.	To teach the energy, economic, and environmental issues of power plants.

UNIT I	COAL BASED THERMAL POWER PLANTS	9

Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, All types of valves, Boiler Safety valves and relief valves, Pipes and tubes for boiler pressure parts, Steam & Heat rate, Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems.

UNIT II	DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS	9

Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems.

UNIT III	NUCLEAR POWER PLANTS	9

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors: Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), Canada Deuterium-Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.

UNIT IV	POWER FROM RENEWABLE ENERGY	9

Hydro Electric Power Plants –Classification, Typical Layout and associated components including Turbines. Principle, Construction and working of Wind, Tidal, OTEC, Solar Photo Voltaic (SPV), Solar Thermal, Geothermal, Biogas and Fuel Cell power systems.

UNIT V	ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS	9

Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants - ESP- Electrostatic Preceptor - Repair & Maintenance cost and selling cost.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand the layout, construction and working of the components inside a coal based thermal power plant.	2
CO2	Describe the working of diesel and integrated gasifier power plants.	2
CO3	Interpret various types of nuclear reactors and hydraulic power plant and their components.	2

CO4	Describe various sources of renewable energy and types of power plants.	2
CO5	Evaluate various performance parameters associated with power plantsystems and interpret economics of power generation and pollution control methods	3

TEXTBOOKS:

1.	Nag.P.K., "Power Plant Engineering", Fourth Edition, Tata McGraw Hill Publishing Company Ltd., 2017.
2.	R.K.Rajput., "A Textbook of Power Plant Engineering" , Fifth Edition, Laxmi Publications.,2016

REFERENCES:

1.	El-Wakil. M.M, "Power Plant Technology", Tata McGraw –Hill Publishing Company Ltd., 2010.
2.	Black & Veatch, "Power Plant Engineering", Springer Publications,1996.
3.	Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, "Power Plant Engineering", Second Edition, Standard Handbook of McGraw Hill, 1998.
4.	Godfrey Boyle, "Renewable energy, Power for a Sustainable Future", Oxford University Press, 2012.
5.	N.K. Bansal, "Non-Conventional Energy Resources", Vikas Publishing House, 2014.

E-RESOURCES:

1.	https://nptel.ac.in/courses/112107291/
2.	https://onlinecourses.nptel.ac.in/noc24_me57/preview
3.	https://nptel.ac.in/courses/103103206

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2	2	2										3	
2	2	2	2										3	
3	2	2	2										3	
4	2	2	2										3	
5	2	2	2	1									3	

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

ME22087	PRINCIPLES OF MANAGEMENT (Common to ME, AE, EE, IT and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	Implement management principles to optimize resource utilization, streamline processes, and minimize waste, ultimately increasing operational efficiency and productivity.
2.	Utilize management principles to align organizational activities with strategic objectives, ensuring that tasks are prioritized and executed efficiently to achieve desired outcomes.
3.	Apply management principles to foster employee development, providing training, support, and opportunities for growth, thereby enhancing individual and team performance and contributing to organizational success.

UNIT I	Management	7

Definition, Nature, Importance, Evolution of Management thought, Contributions made by Taylor, Fayol, Hawthorne Experiment, Maslow Theory, Is management art or science, Functions of manager, Ethics and social responsibility in Management.

UNIT II	Planning, Controlling and Decision Making	10

Planning (Steps of planning, why management starts with planning, types of plans, barriers to effective planning, operational planning, strategic planning, McKinsey's 7S Framework approach), SWOT analysis, MBO, controlling (Concept, Relationship with planning, Process of controlling, Dimensions of control and huma response to control), Decision Making (Nature, process, Certainty and uncertainty, decision tree, group aided decisions, brainstorming)

UNIT III	Organizing & Staffing	10

Organizing (Concept, Nature, Process, Authority and Responsibility, Delegation and Empowerment, Centralization and Decentralization, Departmentation), Staffing (concept, manpower planning, Job Design, recruitment and selection, training and development, performance appraisal)

UNIT IV	Leadership and Communication	10

Leadership - role of leadership and definition, should managers lead, style of leadership, development of leadership, leadership behavior. Communication - Process, tools of communication, electronic media in communication.

UNIT V	Group Dynamics and Recent Trends in management	8

Concept of groups, stages in group formation, types of groups, group synergy, work team's vs work groups, Environment friendly management, changes in management, Crisis management, TQM, Stress management, international management.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand the basic concepts and theories of management	2
CO2	Understanding the Functions of management	2
CO3	Understand the impact of communication and Leadership on the management style	2

CO4	To understand the formation of groups and group dynamics	3
CO5	To understand the recent trends in management in the modern world	3

TEXTBOOKS:

1.	Robbins & Caulter, "Management", Prentice Hall of India, 8th Edition.
2.	Koontz, "Principles of Management", Tata McGrew Hill, 1st Edition 2008

REFERENCES:

1.	L.M. Prasad, "Principles & Practices of Management", Sultan chand & Sons, New Delhi.
2.	Parag Diwan, "Management Principles and Practices", Excel Books, New Delhi.
3.	Stoner, Freeman, Gilbert. Jr, "Management", Prentice Hall of India, 6th Edition

E-RESOURCES:

1.	https://onlinecourses.nptel.ac.in/noc23_mg33/preview
2.	https://archive.nptel.ac.in/Harddisk/Direct_Download.html

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	1	2	2	2		2	1		2	1	1	1	3	
2	1	1	2	1		1	1		1	2	2	1	3	
3	1		1	1	3		2	3	3		2	1	3	
4	1		1	1	1	2	3	1			3	1	3	
5	1	3	3	2	3	2				3	1	1	3	

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

ME22088	VIBRATION AND NOISE CONTROL (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To select appropriate sensors and techniques for diagnosing typical machinery malfunctions.
2.	To isolate the affected machinery components, recognize various common problems, and make recommendations for continued operation or scheduled repairs.

UNIT I	**FUNDAMENTALS OF VIBRATION**	**9**

Introduction -Sources of vibration- Types of vibration, Types of Damping - Single degree freedom systems with and without damping –Determination of Natural frequency for single degree freedom systems.

UNIT II	**TWO DEGREE FREEDOM SYSTEM**	**9**

Free vibration of two-degree freedom system, determination of natural frequency. Forced vibration – Transmissibility. Vibration isolation - Vibration Isolation methods - Dynamic Vibration Absorber.

UNIT III	**MULTI-DEGREE FREEDOM SYSTEM**	**9**

Multi Degree Freedom System –Influence Coefficients and stiffness coefficients, influence coefficients – Eigen values and Eigen vectors – Flexibility Matrix and Stiffness Matrix -Matrix Iteration Method – Approximate Methods: Dunkerley, Rayleigh's, and Holzer Method

UNIT IV	**ENGINEERING NOISE AND ITS CONTROL**	**9**

Introduction-Sound Power, Sound Intensity and Sound pressure level. Sound spectra. The decibel scale-Decibel addition, subtraction, and averaging- Loudness, Weighting networks, Equivalent sound level. Noise: Effects, Ratings and Regulations. Noise: Sources, Isolation and control-Industrial noise sources-Industrial noise control strategies-Noise control at the source, along the path and at the receiver

UNIT V	**MEASUREMENTS AND CONTROL OF VIBRATIONS**	**9**

Vibration Measuring Devices: Transducers, vibration pickups-Vibration exciters: mechanical, hydraulic –Frequency measuring instruments: single reed, multi reed and stroboscope. Experimental modal analysis- FFT analyzers - Vibration control methods and devices- isolators, absorbers and balancing

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand the importance of vibration in the design of Machine parts.	2
CO2	Develop the mathematical model and determine the natural frequency of single degree and two degree of freedom vibrations.	3
CO3	Develop the mathematical model, equation of motion and determine the natural frequency of multi degree of freedom.	3
CO4	Discuss about Noise and its control.	2
CO5	Advocate suitable methods for measuring and controlling the motions of mechanical systems.	3

TEXTBOOKS:	
1.	Rao, S.S.," Mechanical Vibrations", Pearson Education; Sixth edition, 2018.
2.	G.K.Groover., "Mechanical Vibrations", New Chand &Bros, Roorkee, Reprint 2014.
REFERENCES:	
1.	Ramamurti. V, "Mechanical Vibration Practice with Basic Theory", Narosa, New Delhi,2000.
2.	Dukkipati RV, Advanced Mechanical Vibrations, Narosa Publications, 2008
3.	Kelly SG, Mechanical Vibrations, McGrawHill (India) Ltd., 2015
E-RESOURCES:	
1.	https://nptel.ac.in/courses/112/107/112107212/
2.	https://nptel.ac.in/courses/112/103/112103111/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2								1		1	3	
2	3	2								1		1	3	
3	3	2								1		1	3	
4	3	2								1		1	3	
5	3	2								1		1	3	

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