Sri Venkateswara College of Engineering

Autonomous Institution, Affiliated to Anna University, Chennai
Approved by the AICTE, Accredited by NAAC

B.E., Mechanical 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	01.	The courses "Scientific Thoughts in Tamil" in Semester I and "Heritage of Tamil" in Semester II are introduced as per the recommendations of Anna University/Government of Tamil Nadu.			
	02.	In the subject Engineering Drawing the topic “Intersection of surfaces has been included so as to have a better visualization of interpenetrated surfaces.			
	03.	In the course “Production Drawing Laboratory”, instead of giving the assembly drawing sheet, the cut section of the model will be given where the students have to physically measure the dimensions of the component and also do the 2D drafting using AutoCAD / Fusion 360. This will enable the students to enrich their measuring skills and will gain skill in various tolerances			
	04.	Analytical calculations have been included in the Manufacturing Processes			
	05.	The Manufacturing processes theory and laboratory is taught in II semester itself.			

SRI VENKATESWARA COLLEGE OF ENGINEERING,

(An Autonomous Institution, Affiliated to Anna University, Chennai – 600025)

REGULATIONS 2022

B.E. MECHANICAL ENGINEERING

CHOICE BASED CREDIT SYSTEM

PROGRAM EDUCATIONAL OBJECTIVES(PEOs)

I. The graduates of the Mechanical Engineering program will possess technical knowledge, skill and ethical values for working effectively as individual or team members in their career and reach higher technical, Managerial or leadership roles offering solutions to engineering, environmental and societal issues in reputed organizations.

II. The graduates of the Mechanical Engineering program will acquire higher education and emerge successful.

III. The graduates of the Mechanical Engineering program will venture into entrepreneurship and become job creators.

PROGRAM OUTCOMES(POs)

PO	GRADUATE ATTRIBUTES
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 analyse 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 problemsanddesignsystemcomponentsorprocessesthatmeetthespecifiedneedswithapprop riate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4.	**Conduct investigations of complex problems**: User 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 modeling 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 practices.
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.

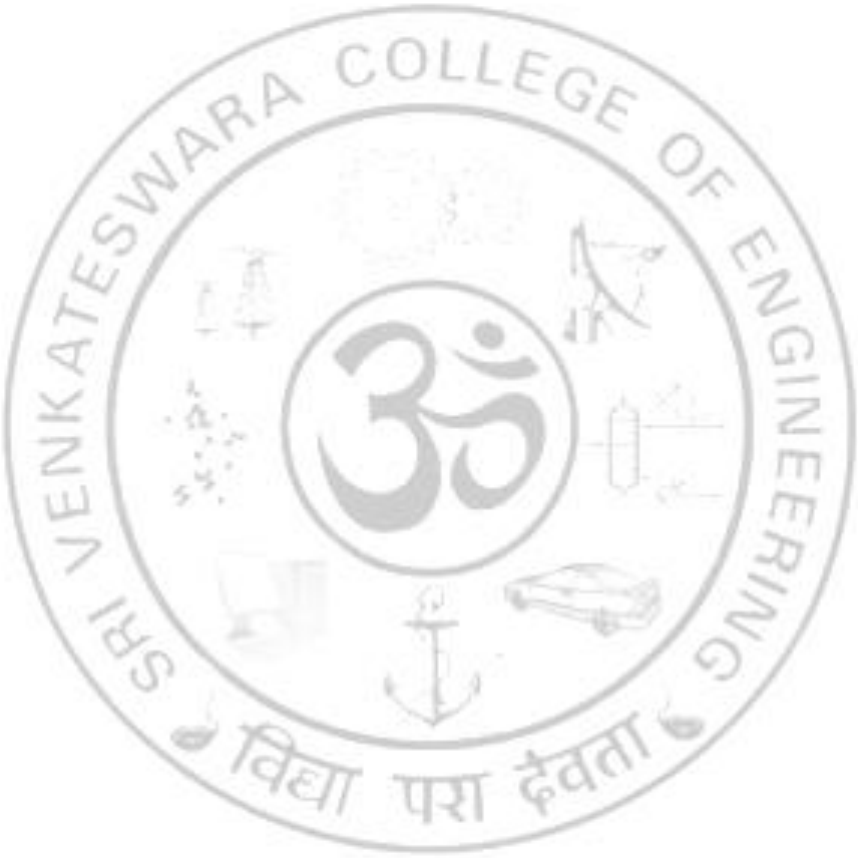
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
9. **Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** 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 independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES(PSOs)

1. Apply the knowledge of applied mathematics and industrial standards to design, model and analyze the machine elements and systems in the field of Mechanical Engineering using latest tools.
2. Apply the knowledge of various processes in manufacturing and industrial engineering practices for the fabrication of various engineering components.
3. Apply the knowledge acquired in the field of thermal science to solve the engineering problems related to design of thermal equipment and evaluating their performance.

PEO's–PO's & PSO's MAPPING:

POs	PEOs				
	I	II	III	IV	V
1.	☐				
2.		☐			
3.			☐		
4.		☐	☐		
5.	☐	☐			
6.		☐	☐		
7.		☐			
8.		☐			
9.			☐		
10.		☐			
11.		☐			
12.	☐				
13.			☐		
14.	☐				
15.	☐		☐		


SRI VENKATESWARA COLLEGE OF ENGINEERING
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SRI VENKATESWARA COLLEGE OF ENGINEERING,

(An Autonomous Institution, Affiliated to Anna University, Chennai – 600025)

REGULATIONS 2022

CHOICE BASED CREDIT SYSTEM

B.E. MECHANICAL ENGINEERING

CURRICULUM AND SYLLABI

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY#	PERIODS PER WEEK				TOTAL Hours	Prerequisite	Position
				L	T	P	C			
1.	IP22151	Induction Program	-	-	-	-	-	-	-	-
Theory Subjects										
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, MN)**	ES	3	0	0	3	3	Nil	F
8.	ME22101	Engineering drawing **(Common to ME, MN, MR)**	ES	2	1	0	3	3	Nil	F
Practical Subjects										
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, MN)**	ES	0	0	3	1.5	3	Nil	F
			Total	**18**	**2**	**7**	**23.5**	**27**		

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY#	PERIODS PER WEEK				TOTAL Hours	Prerequisite	Position
				L	T	P	C			
Theory Subjects										
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
7.	ME22202	Manufacturing Processes	PC	3	0	0	3	3	Nil	F
Practical Subjects										
8.	ME22211	Production Drawing Laboratory (Common to ME, MN)	ES	0	0	4	2	4	Nil	F
9.	ME22212	Manufacturing Processes Laboratory	PC	0	0	3	1.5	3	Nil	F
10.	EE22111	Basic Electrical and Electronics Engineering Laboratory (Common to all Branches except EC)	ES	0	0	2	1	2	Nil	F
			Total	**19**	**2**	**9**	**25.5**	**30**		

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY#	PERIODS PER WEEK				TOTAL Hours	Prerequisite	Position
				L	T	P	C			
1.	MA22357	Transforms and Differential Equations	BS	3	1	0	4	4	Nil	F
2.	ME22301	Engineering Thermodynamics	PC	3	0	0	3	3	Nil	F
3.	EE22359	Electrical Drives and Control: Theory and Practices (Common to ME and MN)	ES	2	0	2	3	4	Nil	F
4.	ME22302	Mechanics of Materials (Common to ME and MN)	PC	2	1	0	3	3	Nil	F
5.	ME22303	Machine Tools Operations	PC	3	0	0	3	3	Nil	F
6.	ME22309	Industrial Metallurgy: Theory and Practices	PC	2	0	2	3	4	Nil	F
7.	ME22311	Machine Tools Operations Laboratory	PC	0	0	3	1.5	3	Nil	F
8.	ME22312	Mechanics of Materials Laboratory	PC	0	0	3	1.5	3	Nil	F
		Total		**15**	**2**	**10**	**22**	**27**		

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY#	PERIODS PER WEEK				TOTAL Hours	Pre requisite	Position
				L	T	P	C			
1.	GE22451	Environmental Sciences and Sustainability (Common to All Branches)	BS	3	0	0	3	3	Nil	F
2.	ME22401	Fluid Mechanics	PC	2	1	0	3	3	Nil	F
3.	ME22402	Kinematics of Machinery	PC	2	1	0	3	3	Nil	F
4.	ME22403	Thermal Engineering	PC	2	1	0	3	3	ME22301	F
5.	MN22408	Hydraulics and Pneumatics for Automation: Theory and Practices (Common to MN and ME)	PC	2	0	2	3	4	Nil	F
6.	ME22409	Design Thinking: Theory and Practices	EE	1	0	2	2	3	Nil	F
7.	ME22411	Computer Aided Modeling 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
9.	ME22413	Comprehension I	EE	0	0	2	1	2	Nil	F
		Total		**12**	**3**	**12**	**21**	**27**		

SEMESTER V

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY#	PERIODS PER WEEK				TOTAL Hours	Pre requisite	Position
				L	T	P	C			
1.	ME22501	Dynamics of Machinery	PC	2	1	0	3	3	Nil	F
2.	ME22502	Failure Analysis and Prevention	PC	3	0	0	3	3	Nil	F
3.	ME22503	Heat and Mass Transfer	PC	3	1	0	4	4	ME22301	F
4.	ME22504	Machine Components Design	PC	2	1	0	3	3	ME22302	F
5.		Professional Elective I	PE	3	0	0	3	3	Nil	M
6.		Open Elective I	OE	3	0	0	3	3	Nil	M
7.	ME22511	Dynamics and Vibrations Laboratory	PC	0	0	3	1.5	3	Nil	F
8.	ME22512	Heat Transfer, Refrigeration and Air conditioning Laboratory	PC	0	0	3	1.5	3	Nil	F
9.		Mandatory Course	MC	3	0	0	0	3	Nil	F
			Total	**19**	**3**	**6**	**22**	**28**		

&**Mandatory Course is a Non-credit Course (Student shall select one course from the list given under MC)**

SEMESTER VI

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY#	PERIODS PER WEEK				TOTAL Hours	Pre requisite	Position
				L	T	P	C			
1.	ME22601	Design of Transmission systems	PC	2	1	0	3	3	Nil	F
2.	ME22602	Metrology and Quality Control: Theory and Practices	PC	2	0	2	3	4	Nil	F
3.		Professional Elective II	PE	3	0	0	3	3	Nil	M
4.		Professional Elective III	PE	3	0	0	3	3	Nil	M
5.		Professional Elective IV	PE	3	0	0	3	3	Nil	M
6.		Open Elective II	OE	3	0	0	3	3	Nil	M
7.	ME22611	MATLAB for Mechanical Engineers Laboratory	PC	0	0	4	2	3	Nil	F
8.	HS22511	Interview and career skills Laboratory (Common to AD, AE, CS, EE, EC, IT, MR, ME AND MN)	HS	0	0	3	2	3	Nil	F
9.	ME22612	Comprehension II	EE	0	0	2	1	1	Nil	F
			Total	**16**	**1**	**11**	**23**	**26**		

SEMESTER VII

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY#	PERIODS PER WEEK				TOTAL Hours	Pre requisite	Position
				L	T	P	C			
1.	ME22701	Engineering Ethics and Human Values (Common to ME and MN)	HS	3	0	0	3	3	Nil	F
2.	ME22707	Digital Manufacturing: Theory and Practices	PC	1	0	4	3	5	Nil	F
3.	ME22708	Energy Conversion Techniques: Theory and Practices	PC	2	0	2	3	4	Nil	F
4.	ME22709	Computer Aided Engineering: Theory and Practices (Common to ME and MN)	PC	1	0	4	3	5	Nil	F
5.	ME22710	Industrial Robotics: Theory and Practices	PC	2	0	2	3	4	Nil	F
6.		Professional Elective V	PE	3	0	0	3	3	Nil	M
7.		Professional Elective VI	PE	3	0	0	3	3	Nil	M
8.	ME22712	Industrial training/Internship #	EE	-	-	-	2	0	Nil	M
9.		Value Added Course^	VD	2^	0	0	0	2^	Nil	M
			Total	**15**	**0**	**12**	**23**	**27**		

#Two weeks Summer Internship carries one credit, and it will be done on or before VI semester summer vacation and same will be evaluated in VII semester. To earn two credits, students must complete for week internship program, either two two weeks internship or one four-week internship program.

^Value added course to be completed between III and VII Semesters

SEMESTER VIII

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY#	PERIODS PER WEEK				TOTAL Hours	Position
				L	T	P	C		
1.	ME22811	Project Work	EE	0	0	20	10	20	F
			Total	**0**	**0**	**20**	**10**	**20**	

VERTICALS FOR PROFESSIONAL ELECTIVES, HONORS & MINOR

	V-1	V-2	V-3	V-4	V-5	V-6	V-7	V-8	V-9
Title	**SPECIAL ELECTIVE GROUP (Common to All branches)**	**PRODUCT AND PROCESS DEVELOPMENT**	**DIGITAL AND GREEN MANUFACTURING**	**LOGISTICS AND SUPPLY CHAIN MANAGEMENT**	**CLEAN AND GREEN ENERGY TECHNOLOGIES**	**SMART MANUFACTURING**	**INDUSTRIAL AUTOMATION**	**DIVERSIFIED COURSES GROUP 1**	**DIVERSIFIED COURSES GROUP 2**
1	Financial Statement Analysis (Common to All branches)	Design For Manufacturing, Assembly and Environment (Common to ME and MN)	Digital Manufacturing and Internet of Things (Common to ME and MN)	Business Analytics for Management Decision (Common to ME and MN)	Biomass Conversion and Biorefinery (Common to ME and MN)	Digital Twin and Industry 5.0 (Common to ME and MN)	AI and ML for Automation (Common to MN and ME)	Automobile Engineering (Common to ME and MN)	Data Science for Industrial Automation: Theory and Practices (Common to MN and ME)
2	Introduction to Securities Market (Common to All branches)	Failure Modes and Effects Analysis (Common to ME and MN)	Sustainable Manufacturing (Common to ME and MN)	Enterprise Resource Planning (Common to ME and MN)	Carbon Footprint Estimation and Reduction Techniques (Common to ME and MN)	Drone Technologies (Common to ME and MN)	Applied Robotics	Composite Materials and Mechanics (Common to ME and MN)	Electric and Hybrid Vehicles (Common to ME, MN and AE)
3	Option Trading Strategies (Common to All branches)	New Product Development (Common to ME and MN)	Environmental Impact Assessment (Common to ME and MN)	Industrial Engineering and Management (Common to ME and MN)	Energy Conservation and Waste Heat Recovery (Common to ME and MN)	Industrial Network and Protocol (Common to ME and MN)	Controllers for Automation: Theory and Practices (Common to MN and ME)	Heating, Ventilation and Air Conditioning Systems (Common to ME and MN)	Gas Dynamics and Jet Propulsion
4	Corporate Finance (Common to All branches)	Product Life Cycle Management (Common to ME and MN)	Green Manufacturing Design and Practices (Common to ME and MN)	Logistics in Manufacturing, Supply Chain and Distribution (Common to ME and MN)	Energy Efficient Buildings (Common to ME and MN)	Intelligent Physical Systems (Common to ME and MN)	Industrial Internet of Things: Theory and Practices (Common to MN and ME)	Industrial Safety Engineering (Common to ME and MN)	Industrial Piping Engineering
5	Managerial Economics (Common to All branches)	Quality and Financial Concepts in Product Development (Common to ME and MN)	Green Supply Chain Management (Common to ME and MN)	Sustainable Supply Chain Management (Common to ME and MN)	Energy Storage Devices (Common to ME and MN)	Machine Vision and Image Processing (Common to ME and MN)	Microcontroller and Embedded Systems	Instrumentation and Control Systems (Common to ME and MN)	Mechatronics
6	Project Management (Common to All branches)	System Design for Sustainability (Common to ME and MN)	Lean Manufacturing (Common to ME and MN)	Total Quality Management (Common to ME and MN)	Hydrogen Energy: Production, Storage, Transportation and Safety (Common to ME and MN)	Robot Operating Systems (Common to ME and MN)	Modern Material Handling Systems (Common to MN and ME)	Power Plant Engineering (Common to ME and MN)	Operations Research and Management (Common to MN and ME)
7	Mathematics for AI & ML (Common to All branches)	Value Engineering and Process Planning (Common to ME and MN)	Statistical and Quality Techniques for Manufacturing (Common to ME and MN)	Warehousing Automation (Common to ME and MN)	Renewable Energy Resources (Common to CH, ME, MN and MR)	Robotics for Smart Manufacturing (Common to ME and MN)	Sensors and Instrumentation	Principles of Management (Common to BT, ME and MN)	Smart and Biomaterials (Common to MN and ME)
8**	NA	Product Life Cycle Management Laboratory (Common to ME and MN)	Digital Manufacturing and IoT Laboratory (Common to ME and MN)	Project Management Laboratory (Common to ME and MN)	Energy Auditing laboratory (Common to ME and MN)	Mini Project (Common to ME and MN)	Mini Project (Common to ME and MN)	Vibration and Noise Control (Common to ME and MN)	Tribology in Design

**S. No.8 Subject in the Vertical 1 to 6, is only meant for B.E. Honors or B.E Minor Degree

PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL 1: SPECIAL ELECTIVE GROUP
(Common to All branches)

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

VERTICAL 2: PRODUCT AND PROCESS DEVELOPMENT

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY#	PERIODS PER WEEK				TOTAL Hours
				L	T	P	C	
8.	ME22021	Design For Manufacturing, Assembly and Environment (Common to ME and MN)	PE	3	0	0	3	3
9.	ME22022	Failure Modes and Effects Analysis (Common to ME and MN)	PE	3	0	0	3	3
10.	ME22023	New Product Development (Common to ME and MN)	PE	3	0	0	3	3
11.	ME22024	Product Life Cycle Management (Common to ME and MN)	PE	3	0	0	3	3
12.	ME22025	Quality and Financial Concepts in Product Development (Common to ME and MN)	PE	3	0	0	3	3
13.	ME22026	System Design for Sustainability (Common to ME and MN)	PE	3	0	0	3	3
14.	ME22027	Value Engineering and Process Planning (Common to ME and MN)	PE	3	0	0	3	3
15.	ME22020	Product Life Cycle Management Laboratory (Common to ME and MN)		0	0	4	2	4

VERTICAL 3: DIGITAL AND GREEN MANUFACTURING

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

VERTICAL 4: LOGISTICS AND SUPPLY CHAIN MANAGEMENT

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

VERTICAL 5: CLEAN AND GREEN ENERGY TECHNOLOGIES

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

VERTICAL 6: SMART MANUFACTURING

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

VERTICAL 7: INDUSTRIAL AUTOMATION

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY#	PERIODS PER WEEK				TOTAL Hours
				L	T	P	C	
1.	MN22701	AI and ML for Automation (Common to MN and ME)	PE	3	0	0	3	3
2.	ME22072	Applied Robotics	PE	3	0	0	3	3
3.	MN22509	Controllers for Automation: Theory and Practices (Common to MN and ME)	PE	2	0	2	3	3
4.	MN22608	Industrial Internet of Things: Theory and Practices (Common to MN and ME)	PE	2	0	2	3	3
5.	ME22075	Microcontroller and Embedded Systems	PE	3	0	0	3	3
6.	MN22601	Modern Material Handling Systems (Common to MN and ME)	PE	3	0	0	3	3
7.	ME22077	Sensors and Instrumentation	PE	3	0	0	3	3
8.	ME22070	Mini Project (Common to ME and MN)	PE	0	0	4	2	4

VERTICAL 8: DIVERSIFIED COURSES GROUP 1

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

VERTICAL 9: DIVERSIFIED COURSES GROUP 2

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY#	PERIODS PER WEEK				TOTAL Hours
				L	T	P	C	
1.	MN22709	Data Science for Industrial Automation: Theory and Practices (Common to MN and ME)	PE	2	0	2	3	3
2.	AE22602	Hybrid and Electric Vehicles (Common to AE, ME, and MN)	PE	3	0	0	3	3
3.	ME22091	Gas Dynamics and Jet Propulsion	PE	3	0	0	3	3
4.	ME22092	Industrial Piping Engineering	PE	3	0	0	3	3
5.	ME22093	Mechatronics	PE	3	0	0	3	3
6.	MN22403	Operations Research and Management (Common to MN and ME)	PE	2	1	0	3	3
7.	MN22075	Smart and Biomaterials (Common to MN and ME)	PE	3	0	0	3	3
8.	ME22094	Tribology in Design	PE	3	0	0	3	3

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

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY#	PERIODS PER WEEK				TOTAL Hours
				L	T	P	C	
1.	OE22002	Lean Six Sigma	OE	3	0	0	3	3
2.	OE22004	Robotics and Programming: Theory and Practices	OE	2	0	2	3	4

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

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY#	PERIODS PER WEEK				TOTAL Hours
				L	T	P	C	
3.	OE22001	Green Manufacturing	OE	3	0	0	3	3
4.	OE22003	3D Printing and Design: Theory and Practices	OE	2	0	2	3	4

VALUE ADDED COURSES

(To be completed in between III semester to VI semester)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C	TOTAL Hours
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 to All Branches)	VA	2	0	0	0	2
9.	VC22002	Advances in Entrepreneurship Development (Common to All Branches)	VA	2	0	0	0	2
10.	VC22003	Communicative German (Common to all branches)	VA	2	0	0	0	2
11.	VC22004	Communicative Hindi (Common to all branches)	VA	2	0	0	0	2
12.	VC22005	Communicative Japanese (Common to all branches)	VA	2	0	0	0	2
13.	VC22006	Design Thinking and Prototyping Laboratory (Common to All Branches)	VA	1	0	2	0	2

MANDATORY COURSES

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY#	PERIODS PER WEEK				TOTAL Hours
				L	T	P	C	
1.	MC22001	Indian Constitution and Society (Common to all branches)	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

GENERAL ENGINEERING

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY#	PERIODS PER WEEK				TOTAL Hours
				L	T	P	C	
1.	GN22001	Introduction to NCC for Engineers. (Common to all branches)	GN	2	0	2	0	4
2.	GN22002	Yoga and physical culture (Common to all branches)	GN	0	0	2	0	2
3.	GN22003	Introduction to Fine arts (Common to all branches)	GN	2	0	0	0	2

Summary

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				2	3		14
2	Basic Science courses (BS)	12	7	4	3					26
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc (ES)	7.5	9	3						19.5
4	Professional Core courses (PC)		4.5	15	15	16	8	12		70.5
5	Professional Elective courses relevant to chosen specialization/branch (PE)					3	9	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 (EE)				3		1	2	10	16
8	Mandatory Courses (MC)					0				0
	Semester wise Total	**23.5**	**25.5**	**22**	**21**	**22**	**23**	**23**	**10**	**170**

SYLLABUS
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	**பாட திட்டத்தின் 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 **19**

Listening - short video clips - conversational scenes from 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 etiquette. 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 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, learners 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**	**3**
1										3					
2										3					
3										3					
4										3					
5										3					

MA22151	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, learners 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", 9th 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		4	5	6	7	8	9	10	11	12	1	2	3
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, learners 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**	**3**
1	3	2		2						1					
2	3	2		2						1		2			
3	3		2		3	2	1			1					
4	3		2		3	2	1			1		2			
5	3	2	2							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 nanophononics 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, learners 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**	**3**
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, learners 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", 2nd 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", 7th Edition, Pearson Education, 2016.

COURSE ARTICULATION MATRIX:

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
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	1	0	3

COURSE OBJECTIVES:

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

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 - isometric 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, learners 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, 2011.

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 Textbook of Engineering Graphics", Dhanalakshmi Publishers, 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**	**3**
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

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.

TOTAL: 30 HOURS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, learners 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 or not 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	3
1	3	3	2	3	2				3	1		2			
2	3	3		3		2			3	1		2			
3	3	3	2	3	2	2			3	1		2			
4	3	3		3					3	1		2			
5	3	3		3	2				3	1		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.	Torsional Pendulum, stop clock,suspension metallic wire: two different thickness, two identical cylindrical mass, screwgauge, wooden scale	5
2.	Simple harmonic oscillations ofcantilever: 1-meter wooden scale, G-clamp, weight hanger with slottedweights, Vernier caliper, Screw gauge, stop clock	5
3.	Non-uniform bending: 1-meter wooden scale, two-knife edges, travelling microscope, weight hanger with slotted weights, screwgauge, Vernier caliper, pin	5
4.	Uniform bending: 1meter woodenscale, two-knife edges, travelling microscope, two weight hanger with slotted weights, screw gauge, Vernier caliper, pin	5
5.	He-Ne/Diode laser (red), Greendiode laser, Grating, Screen, Iron stand (3 Nos), 1m wooden scale, thread.	5
6.	45^0 inclined glass plate set-up, twooptically plane glass plates,sodium vapour lamp, travelling microscope, thin wire/thin strip of paper	5
7.	Diode laser (green or red), fiberOptic cable, movable arrangement with a screen for measuring spot size (zig), meter scale, stand	5
8.	Diode laser (green or red), iron stand, compact disc, 1m-wooden scale, screen, stand	5
9.	He-Ne laser, CCl_4 liquid or Benzene liquid, Glass cell with sample liquid (Kerosene/Toluene/Turpentine/Benzene or CCl4 liquid), RF oscillator fitted with a frequency meter, Piezoelectric crystal, Electrodes (crystal holder), Screen, iron stand (two numbers), 1m wooden scale, thread.	5
10.	Ultrasonic interferometer apparatus with high frequency wave generator, cell, micrometer, PZ crystal, water, or other liquids	5
11.	Post office box, 5V power supply, thermometer, galvanometer, semiconductor (thermistor), variabletemperature bath set-up (oil, temperature controller, vessel, hot plate.	5
12.	Photoelectric effect apparatus withnecessary accessories, tungsten-halogen lamp, Cesium-typevacuum photodiode.	5
13.	Michelson interferometer set-up,sodium vapor lamp and accessories	5
14.	Meld's string apparatus, thread andweight pan, weight hanger and slotted weights.	5
15.	Lattice dynamics kit with built-in audio oscillator and electrical transmission line (for mono and di-atomic lattices), general purpose CRO having XY mode.	5
16	Potentiometer	15

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 for 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

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.

TOTAL: 30 HOURS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, learners 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, "Textbook of quantitative analysis chemical analysis", ELBS 5th Edition. 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	3
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 EQUIPMENT FOR A BATCH OF 30 STUDENTS

SL. No	ITEM DESCRIPTION	QUANTITY
1.	Common apparatus: Pipette, Burette, conical flask, porcelain tile, dropper	30 each
2.	Iodine flask	30
3.	pH meter	5
4.	Conductivity meter	5
5.	Spectrophotometer	5
6.	Oswald/Ubbelohde Viscometer	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 size of() 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

TOTAL: 45 HOURS

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**	**3**
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'S FOR A BATCH OF 30 STUDENTS

Sl. No	ITEM DESCRIPTION	QUANTITY
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 worship 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 evidence – 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 Software – 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. .	To enable learners, define and understand technical communication and scientific writing
2. .	To expose learners to writing for scientific purposes
3.	To expose learners to drafting correspondences for business purposes
4.	To expose learners to writing for documenting purposes
5.	To enable students, have a holistic understanding of job interviews and recruiting process
6.	To expose learners to nuances of seminar presentation, group discussion, and public speaking

UNIT I **8**

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 **10**

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 **8**

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 **10**

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 evidence 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

Suggested Activities [task based] – case study, guest lectures as models, problem solving, understanding teamwork.

Assessment:

3 Continuous assessments (reading, writing, grammar, and 3 assignments (1 assignment focuses on

listening 2 assignments focus on speaking, evaluation of students' speeches and recorded clippings)		
CO No.	**COURSE OUTCOMES**	**RBT Level**
At the end of the course, learners will be able to:		
CO1	Understand the nuances of technical communication and scientific writing	**3**
CO2	Present papers and give seminars	**3**
CO3	Discuss in groups and brainstorm	**3**
CO4	Draft business correspondences and write for documenting purposes	**3**
CO5	Face job interviews with confidence	**2**

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

Web Link:

1.	http://www.usingenglish.com
2.	http://www.uefap.com
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**	3
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 Branches except MR)	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

The Students should be made to:

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, learners 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**	3
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-FERROUS 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 (Polarizability) - 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, learners 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 Textbook 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**	3
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, learners 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, 4th Edition, 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**	3
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, learners 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”, 2nd 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 &Company Ltd, 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, 4th Edition, 2007.

COURSE ARTICULATION MATRIX:

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

ME 22202	MANUFACTURING PROCESSES	L	T	P	C
		3	0	0	3

OBJECTIVES:

1.	To impart the importance of casting and its applications
2.	To teach the various metal joining process and how to select the process.
3.	To acquaint the various bulk deformation processes
4.	To teach various sheet metal forming operations and the recent developed forming process for sheet metal
5.	To understand the processing method available for thermoplastics and thermosetting plastics and the powder metallurgy process

UNIT I METAL CASTING PROCESSES **10**

Introduction, Patterns – Materials, Types and Pattern allowances, Cores – Core Prints, Core making and Types of cores, Moulding sand – Properties, Melting Practices – Cupola and Induction Furnaces, Mould – Expendable and Permanent Mould, Green sand Mould preparation, Special casting Processes – Investment casting, Die casting – Hot chamber and Cold Chamber, Slush Casting, Centrifugal Casting – True, Semi and Centrifuging, Continuous Casting, Shell Moulding, CO_2 Process, Stir Casting Process– Defects in casting – solidification time calculations

UNIT II JOINING PROCESSES **10**

Fusion Welding Processes – Types of Gas Welding – Flame Characteristics , Oxy Fuel Gas Welding, Types of Gas welding Technique, Arc Welding – Arc welding Equipment's, Fillers and Flux Materials, Electrodes – Coated electrode designation, Consumable Electrode – Shielded Metal Arc Welding, Submerged Arc Welding, Gas Metal Arc Welding, Flux Cored Arc Welding, Electro slag welding, Electro gas welding, Non Consumable Electrode – Gas Tungsten Arc Welding, Atomic Hydrogen Welding, Plasma Arc Welding, Electron Beam Welding, Laser Beam Welding, Solid State welding – Ultrasonic Welding, Friction Welding – Friction Stir Welding, Resistance welding – Types, Welding defects. Problems related to power calculations in welding

UNIT III BULK DEFORMATION PROCESSES **10**

Metal Forming Classification, Hot working, Cold Working and Warm Working of metals, Recrystallization Temperature.

Forging – Outline of Forging and related operations (Edging, Heading, Fullering, drawing out, Upsetting, Drawing down, Swaging, Blocking, Coining, Trimming), Special forging process - Roll Forging, Iso thermal Forging and Orbital Forging, Defects in Forging

Extrusion Process – Types of Extrusion Process- Direct and Indirect Extrusion, Hydrostatic Extrusion, Impact Extrusion, Side extrusion, Extrusion defects

Rolling Processes – Terminology – Blooms, Billet, Slab, Plate, sheet, Foil, Types of rolling mills, Roll Pass design, Shape rolling operations, Thread Rolling, Ring Rolling, Gear Rolling, Roll piercing process, Rolling defects

Principles of rod, wire, and tube drawing- Seamless tubes and Tube drawing methods

Simple problems in bulk deformation process

UNIT IV SHEET METAL FORMING PROCESSES **10**

Definitions of Various Press Operations – Blanking, Punching, Shaving, Perforating, Lancing, Slitting, Trimming, Bending, Drawing, squeezing, Press working Terminology, Types of dies for

Sheet metal operations, Press Tonnage calculation. Methods to reduce the cutting force - Problems

Sheet Metal Forming operations – Bending and Drawing- Elastic recovery or spring back effect,

Stretch forming, Rubber pad forming, Hydroforming, Metal Spinning – Types,

High Energy Rate Forming Process – Explosive Forming, Magnetic Pulse Forming, Electro Hydraulic

Forming, Superplastic Forming.

UNIT V	PROCESSING OF PLASTICS AND POWDER METALLURGY	5

Types of plastics – Types of Moulding – Injection Moulding, Blow Moulding, Compression Moulding, Transfer Moulding, Rotational Moulding, Extrusion, Thermoforming, Calendaring
Powder Metallurgy – Production of metal Powders, Compaction – Sintering and Finishing, Advantages, and disadvantages of powder metallurgy.

TOTAL : 45 PERIODS

CO No.	COURSE OUTCOMES	RBT LEVEL
At the end of the course, learners will be able to		
CO1	Select a suitable casting process for a given engineering component	3
CO2	Given a material, the students will Apply a suitable joining process	3
CO3	Given a part diagram & its application, will justify a suitable bulk deformation process	3
CO4	identify the necessary operations to be performed on a sheet metal and will select a suitable process for a given application	3
CO5	justify a suitable process for thermoplastics, thermosetting plastics and for cutting tools	3

TEXTBOOKS:

1. Serope Kalpakjian & Steven R. Schmid, "Manufacturing Engineering and Technology", Pearson India Education Services Pvt. Ltd, 7th edition, 2018
2. Dr. P.C. Sharma, "A Textbook of Production Technology (Manufacturing Processes), S. Chand & Company Ltd, 8th edition, 2014

REFERENCES:

1. Mikell P. Groover, "Principles of Modern Manufacturing", SI version, Wiley & Sons Pvt Ltd, Global Edition, 2016
2. R.K. Rajput, "A textbook of Manufacturing Technology (Manufacturing Processes)", Laxmi Publications (p) Ltd, 2016
3. Rao. P.N, "Manufacturing Technology", Tata McGraw Hill Publishing Co. Ltd, Volume 1, 5th edition, 2018
4. Serope Kalpakjian &Stevan R. Schmid, "Manufacturing Processes for Engineering Materials", Pearson India Education Services Pvt. Ltd, 6th edition, 2018

E- Resources

1. http://www.ipme.ru/e-journals/RAMS/no_15418/04_15418_kawasaki.pdf
2. https://pdfs.semanticscholar.org/6f56/4a28d39f1365f337be04922424472dcf3413.pdf
3. https://nptel.ac.in/courses/112107144/

COURSE ARTICULATION MATRIX

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	3	1	2				**2**					**3**		**3**	
2.	3	1	2				**2**					**3**		**3**	
3.	3	1	2				**2**					**3**		**3**	
4.	3	2	3				**2**					**3**		**3**	
5.	3		3				**3**					**3**		**3**	

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. Exposer 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, learners will be able to:		
CO1	read and interpret the production drawings	3
CO2	understand proper fits and tolerances.	5
CO3	generate assembly drawings for various mechanical products	5
CO4	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

E-RESOURCES:

1.	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**	3
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 EQUIPMENT FOR A BATCH OF 30 STUDENTS

SL.No.	ITEM DESCRIPTION	QUANTITY
	HARDWARE	
1.	Computer Server	1
2.	Computer systems networked to the server	30
3.	A3 size plotter	1
4.	Laser Printer	1
	SOFTWARE	
5.	Licensed software for Drafting and Modeling & operating system	30

ME22212	MANUFACTURING PROCESSES LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

1.	To impart the practical knowledge in casting and Joining Process
2.	To impart the basic machining skills in lathe and to equip with the practical knowledge required in the core industries

LIST OF EXPERIMENTS

1.	**CASTING** Study of various types of patterns, pattern materials, foundry tools i. Preparation of green sand mould for single piece pattern ii. Preparation of green sand mould for split patterns iii. Melting of nonferrous alloys and making a casting (Demonstration)
2.	**WELDING** Study of arc welding and gas welding equipment's, types of electrodes i. Fabrication of simple structural shapes using Gas Metal Arc Welding ii. Joining of plates using Metal Inert Gas Welding / Gas Metal Arc Welding iii. Demonstration of Tungsten Arc Welding, Cold Metal Transfer Welding and Friction Stir Welding
3.	**LATHE** Study of lathe, various mechanisms, work holding devices, tool holding devices and various Machining operations i. Plain, Turning and Taper Turning ii. External & Internal Thread cutting & Knurling. iii. Eccentric Turning iv. Estimation of machining time for the above turning processes v. Pin and bush assembly vi. Dismantling and assembly of headstock and tail stock of a lathe.

NOTE:

1. Exposer 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, learners will be able to:		
CO1	identify and perform the operations for a given product diagram for a lathe.	3
CO2	make a green sand mould using different patterns.	5
CO3	select the suitable welding parameters to make a welded component using Arc and MIG welding. The learners will be able to read and interpret the production drawings	5

REFERENCES:	
1.	Serope Kalpakjian & Steven R. Schmid, "Manufacturing Engineering and Technology", Pearson India Education Services Pvt. Ltd, 7th edition, 2018
2.	Dr. P.C. Sharma, "A Textbook of Production Technology (Manufacturing Processes), S. Chand & Company Ltd, 8th edition, 2014

E-RESOURCES:	
1.	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	3
1	3		3					2				3		2	
2	3		3					2				3		2	
3	3		3					2				3		2	

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

SL.No.	ITEM DESCRIPTION	QUANTITY
	HARDWARE	
1.	Centre Lathes	7 Nos
2.	Arc Welding machine	5 Nos
3.	Metal Inert Gas Welding	1 No

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 Staircase 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.

TOTAL: 30 PERIODS

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**	3
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)															

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

SL.No.	ITEM DESCRIPTION	QUANTITY
1.	Verification of Ohms and Kirchhoff'sLaws: DC Regulated power supply (0-30)V, Bread Board, Resistors, Multimeter, Connecting wires.	1 set
2.	Load test on DC Shunt Motor: Ammeter MC (0-20A), Voltmeter MC (0-300) V, Rheostat 7.5 Ω, 10 A, Tachometer, Field Rheostat 175 Ω, 1.5 A, Connecting wires.	1 set
3.	Load test on Self Excited DCGenerator: DC shunt generator (0-300V), Ammeter (0-30 A), (0-2A), Voltmeter (0-30V), Rheostat 175Ω, 250 Ω, Tachometer, Connecting Wires.	1 set
4.	Load test on Single phase Transformer: Ammeter (0-30) A, (0-5) A, Voltmeter (0-150) V, (0-300)V, Wattmeter – 300V, 5A, UPF, Autotransformer, Single phase, transformer, Connecting wires.	1 set
5.	Load Test on Induction Motor: Ammeter MI (0-20A), Voltmeter MI (0-300) V, Wattmeter – 300V, 30 A, Tachometer – Digital, Single phase Induction motor, Connecting Wires.	1 set
6.	A. Experiment on Transistor based application circuits (Inverting and non-inverting amplifier or switching circuits): Transistor (No-BC107), Resistors- 2.2kΩ, 47KΩ, 10KΩ, 560Ω, Capacitors - 10µF, 3.3µF, 22µF, Bread Board, DC Regulated Power supply (0 - 30 V) Variable, CRO, Connecting wires. B. Experiments on OperationalAmplifier based Inverting and non-inverting amplifier: Function Generator 1 KHz, CRO 20 MHz, Dual RPS 0–30V, Op-Amp IC 74, Resistors R1= 100 Ω and RF= 1.5 KΩ, Connecting wires.	1 set
7.	Experiments on ADC: Resistors – 10 KΩ Resistors - 220Ω Capacitor – 150 µF, 10µFADC -0804, Bread Board, Connecting wires, Dual RPS (0–30) V.	1 set
8.	Experiments on 555 timers: IC 555 Timer, Resistor R1, R2 47kΩ, 1kΩ, Resistor R4 220Ω Load, Capacitor, C1 10 µF, Capacitor, C2 0.01 µF, Bread Board, Connecting wires, CRO 20 MHz, 9. 9. RPS (0–30) V.	1 set
9.	DSO: Measurement of Amplitude,Frequency, Time, Phase Measurement using DSO.	1 set

SEMESTER – III

MA22357	TRANSFORMS AND DIFFERENTIAL EQUATIONS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

1.	To introduce Fourier series analysis, this is central to many applications in engineering apart from its uses in solving boundary value problems.
2.	To understand the basic concepts of the Fourier, transform techniques and its application in Engineering.
3.	To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

UNIT I	**PARTIAL DIFFERENTIAL EQUATIONS**	**9+3**

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

		9+3
UNIT II	**FOURIER SERIES**	

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series –Half range cosine series –Parseval's identity – Harmonic analysis.

UNIT III	**APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS**	**9+3**

Classification of PDE – Method of separation of variables - Solution of one-dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two-dimensional equation of heat conduction (excluding insulated edges).

UNIT IV	**FOURIER TRANSFORMS**	**9+3**

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity

UNIT V	**TRANSFORMS AND DIFFERENCE EQUATIONS**	**9+3**

Z- transforms - Elementary properties – Inverse Z - transform (using partial fraction, long division method and residue technique) –Convolution theorem - Formation of difference equations – Solution of difference equations using Z - transform.

	TOTAL: (L45 + T:15): 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, the learners will be able to:		
CO1	Model any arbitrary periodic signal with a combination of sines and cosines.	4
CO2	Mathematically formulate, and thus aid the solution of, physical and other problems involving functions of several variables.	4

CO3	Understand the theory of ordinary differential equations through applications.	3
CO4	Learn analytical methods for solving boundary value problems	4
CO5	Use the Z-transform as a mathematical tool which is used to convert the difference equations in time domain into the algebraic equations in z-domain.	4

TEXTBOOKS:	
1.	Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2011
2.	Grewal. B.S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publishers, Delhi, 2012.
3.	Narayanan.S., Manicavachagom Pillay.T.K and Ramanaiah. G "Advanced Mathematics for Engineering Students" Vol. II & III, S. Viswanathan Publishers Pvt. Ltd.1998.
REFERENCES:	
1.	Bali. N. P and Manish Goyal, "A Textbook of Engineering Mathematics", 7th Edition, Laxmi Publications Pvt Ltd, 2007.
2.	Glyn James, "Advanced Modern Engineering Mathematics", 4th Edition, Pearson Education, 2011.
3.	Ray Wylie. C and Barrett. L. C, "Advanced Engineering Mathematics" Tata McGraw Hill Education Pvt Ltd, Sixth Edition, New Delhi, 2012.
4.	Peter V. O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt. Ltd. 7th Edition, New Delhi, 2012.
5.	Veerarajan. T., "Transforms and Partial Differential Equation", Tata McGraw Hill Publishing Company Limited, New Delhi, 2012
E-RESOURCES:	
1.	https://youtu.be/LwhWZzZzZsU
2.	https://youtu.be/GeJZcfP9A98

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2										2		
CO2	3	3	2										2		
CO3	3	3	2	2									2		
CO4	3	3	2	2									2		
CO5	3	3	2	2									2		

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

ME22301	ENGINEERING THERMODYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To familiarize the students to understand the fundamentals of

1. First Law of thermodynamics and its applications.to various thermal engineering devices
2. Second Law of thermodynamics and its applications.to various thermal engineering devices
3. Steam formation and its application in power generation.
4. Ideal & real gas behavior and thermodynamic relations
5. Psychrometry and gas mixtures.

UNIT I	BASIC CONCEPTS AND FIRST LAW	9

Basic concepts -concept of continuum, comparison of microscopic and macroscopic approach. Path and point functions. Intensive and extensive properties, total and specific quantities. System and their types. Thermodynamic Equilibrium, State, path and process. Quasi-static, reversible and irreversible processes. Heat and work transfer, definition and comparison, sign convention. Displacement work and other modes of work, P-V diagram. Zeroth law of thermodynamics–concept of temperature and thermal equilibrium–relationship between temperature scales –new temperature scales. First law of thermodynamics–application to non-flow and steady systems–unsteady flow processes (Descriptive only).

UNIT II	SECOND LAW AND AVAILABILITY ANALYSIS	9

Heat reservoirs -source and sink. Heat Engine, Refrigerator, Heat pump. Statements of second law and its corollaries. Carnot and reversed Carnot cycles – Performance. Clausius inequality. Concept of entropy, T-S diagram, Tds Equations Entropy change for ideal gases-different processes, principle of increase in entropy. Applications of Second Law. High- and low-grade energy. Available and unavailable energy. Exergy and Irreversibility (Descriptive Only). First law and second law Efficiency

UNIT III	PROPERTIES OF PURE SUBSTANCE	9

Formation of steam and its thermodynamic properties, p-v, p-T, T-v, T-s, h-s diagrams. p-v-T surface. Use of Steam Table and Mollier Chart. Determination of dryness fraction. Application of First and Second law for pure substances. Ideal and actual Rankine cycles, Cycle improvement methods-Reheat and Regenerative cycles

UNIT IV	IDEAL AND REAL GASES, THERMODYNAMIC RELATIONS	9

Properties of Ideal gas -Ideal and real gas comparison-Equations of state for ideal and real gases-Reduced Properties-Compressibility factor-Principle of Corresponding states-Simple Calculations using Generalized Compressibility Chart. Maxwell relations, TDS Equations, Difference and ratio of heat capacities, Energy equation, Joule-Thomson Coefficient, Clausius Clapeyron equation, Phase Change Processes

UNIT V	GAS MIXTURES AND PSYCHROMETRY	9

Mole and Mass fraction, Dalton's, and Amagat's Law. Properties of gas mixture–Molar mass, gas constant, density, change in internal energy, enthalpy, entropy, and Gibbs function. Psychrometric properties, Psychrometric charts. Property calculations of air vapor mixtures by using charts and

expressions. Psychrometric process –adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing. Simple Applications

TOTAL: 45 PERIODS

CO No.	OUTCOMES:	RBT Level
At the end of the course, learners will be able to		
CO1	Apply first law of thermodynamics in various energy transferring and transforming devices.	**3**
CO2	Apply second law of thermodynamics in various energy transferring and transforming devices.	3
CO3	Analyze the performance of steam power plant cycle with the help of steam table and charts.	**4**
CO4	Predict different thermodynamic relations and equations for ideal and real gases.	**3**
CO5	Analyze the properties of Gas mixtures and various Psychrometric process and its applications.	**4**

TEXTBOOKS:

1. Nag P.K "Basic and Applied Thermodynamics" 2nd Edition, Tata McGraw-Hill, New Delhi 2009
2. Natarajan E., "Engineering Thermodynamics: Fundamentals and Applications", Anuragam Publications, 2012.

REFERENCES:

1. Rajput R.K., "Thermal Engineering", Laxmi Publications, Tenth Edition, 2017
2. Yunus A. Cengel and Michael A.Boles "Thermodynamics an engineering approach", 9th Edition Tata McGraw hill Publications. 2019.
3. Holman J.P., "Thermodynamics", 4th Edition, McGraw – Hill 1995.
4. Rathakrishnan E "Fundamentals of Engineering Thermodynamics" 2nd Edition, Prentice –Hall of India Pvt.Ltd, 2006
5. Chattopadhyay.P "Engineering Thermodynamics" 2nd Edition Oxford University Press 2016.
6. Arora C.P "Thermodynamics" Tata McGraw – Hill, New Delhi 2003
7. Gordon J Van Wylen and Richard E Sonntag, "Fundamentals of Classical Thermodynamics" Wiley Eastern, 1987
8. Venkatesh A. "Basic Engineering Thermodynamics" Universities Press (India) Limited 2007

E- Resources:

1. https://nptel.ac.in/courses/112105123
2. https://archive.nptel.ac.in/courses/112/106/112106310/
3. https://nptel.ac.in/courses/112104113
4. https://archive.nptel.ac.in/courses/127/106/127106135/

COURSE ARTICULATION MATRIX

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

EE22359	Electrical Drives and Control: 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	10

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- Industrial Hazards and Safety Measures.

UNIT II	DRIVE MOTOR CHARACTERISTICS & SPECIAL MACHINES	10

DC motors: principle, classification, characteristics, merits & demerits, applications–Three phase Induction motors: principle, classification, characteristics, merits & demerits, applications–Principle, classification, construction and characteristics of stepper motor, BLDC motor, Servo motor.

UNIT III	CONVENTIONAL AND SOLID STATE SPEED CONTROL OF DC AND AC DRIVES	10

Speed control of DC series and shunt motors – Armature and field control, Ward Leonard control system - Using controlled rectifiers and DC choppers –Speed control of three phase induction motor–Inverter fed induction motor drive – Slip power recovery scheme.

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

TOTAL: 60 PERIODS

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 motor, AC motor and special electrical machines 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	Ability to 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, 2022
2.	Vedam Subrahmaniam, "Electric Drives (concepts and applications)", Tata McGraw-Hill, 2017.
3.	Nagrath. I.J. & Kothari. D.P, "Electrical Machines", Tata McGraw-Hill, 2010.

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, 2008.
3.	Partab. H., "Art and Science and Utilisation of Electrical Energy", Dhanpat Rai and Sons, 1994.
4.	Electrical Equipment Handbook: Troubleshooting &Maintenance by Philip Kiameh.

E-RESOURCES

1.https://nptel.ac.in/courses/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**	**3**
1	**3**	**1**	**1**	**2**								**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		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
8.	AC servo motors with loading arrangement.	1
9.	DC servo motors with loading arrangement.	1

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, learners 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	4

	based on calculated stresses, deflection under different conditions.	
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, Jr. 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**	**3**
1.	**3**	**3**		**1**	**1**								**3**		
2.	**3**	**3**		**2**	**1**								**3**		
3.	**3**	**3**											**3**		
4.	**3**	**3**		**2**									**3**		
5.	**3**	**3**											**3**		

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

ME22303	MACHINE TOOLS OPERATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To acquire knowledge about the theory of chip formation, and relationships among force-power-energy, cutting speed-temperature and cutting speed-tool life.
2.	To select suitable machine tools and operations to manufacture a given work piece.
3.	To familiarize the different gear manufacturing methods, machine tools for machining planar surfaces and finishing processes
4.	To familiarize the working principles of non-traditional machining processes.

UNIT I	THEORY OF METAL MACHINING, CUTTING TOOL TECHNOLOGY AND MACHINING ECONOMICS	9

Importance of machining – Classification of material removal processes – Chip formation – Orthogonal cutting model – types of chip formation – Forces in metal cutting – Merchant's circle diagram and equations – Power and energy relationships in machining Cutting temperature and its measurement – Tool wear – Taylor's tool life equation -Tool materials -Single point tool geometry -ASA and OR systems – chip breakers- Cutting fluids – Types, Application methods - flood, mist, MQL - Machinability – Tolerance in Machining - Selection of cutting conditions – Feed and depth of cut – Optimizing cutting speed for maximum production rate and minimum production cost.

UNIT II	LATHE AND DRILLING MACHINE TOOLS	9

Lathe – Classification, Specifications, Operations – Taper turning methods, Thread cutting methods and other operations, Machining time and power estimation, Work holding devices. Capstan and turret lathes – Construction, Work holding devices in turret lathes, Operations – External and internal thread cutting, Production of hexagonal bolt and other simple components -Tooling scheduling chart – Machining cost

Drilling Machines - Classification, Specifications, Work holding devices, Operations – Drilling, Reaming, Boring, Tapping and other operations, Machining time in drilling.

UNIT III	SHAPING, MILLING, BROACHING MACHINE TOOLS OPERATIONS AND GEAR MANUFACTURING	12

Shaper – Classification, Specification, Work holding devices, Machining time in shaping.

Broaching – Push and pull type – Continuous and rotary broaching – Machining time in Broaching.

Milling machines – Classifications, Up and down milling, Indexing in milling machine– Simple, compound, and differential indexing, Operations – Plain, face, end, and other milling operations. Cutting conditions and Machining time in milling.

Gear Generation – Gear geometry -Principle of gear hobbing – Spur and helical gear cutting problems – Advantages and limitations – Principle of gear shaping – spur gear cutting problems – Advantages and limitations.

UNIT IV	GRINDING AND OTHER ABRASIVE PROCESSES	9

Finishing processes: Grinding - Cylindrical grinding – center type and centerless type, surface grinding, Machining time in grinding, grinding wheel specification, Selection of grinding wheel, Polishing and Buffing,

Honing & Lapping, Super Finishing.		
UNIT V	**NON - TRADITIONAL MACHINING PROCESSES**	**6**
Introduction, Classification, Abrasive Jet Machining, Waterjet Machining, Ultrasonic Machining, Electrical Discharge Machining, Wire Cut EDM, Chemical Machining, Electro Chemical machining, Electro chemical grinding, Laser Beam Machining, Electron beam machining, Plasma Arc Machining - Working Principles, Equipment used and Applications.		
		TOTAL: 45 PERIODS

CO No	**COURSE OUTCOMES**	**RBT Level**
At the end of the course, learners will be able to:		
CO1	Identify the types of chips for a given material, estimate the cutting force, power, energy, tool life and temperature during machining, and will justify the tool angles for a given single point cutting tool.	3
CO2	Determine the operational sequence for a given a part diagram to machine on lathe and determine its machining cost.	3
CO3	Interpret the given part diagram and select appropriate machine tools to machine the product.	3
CO4	Select an appropriate finishing process for a given application.	4
CO5	Select an appropriate non – traditional machining process based on their principles and limitations.	4
1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)		

TEXTBOOKS:

1.	P N Rao, "Manufacturing Technology: Metal Cutting and Machine Tools", Mc-Graw Hill, Volume 2, 4th Edition, 2018.
2.	Serope Kalpakjian & Steven R. Schmid, "Manufacturing Engineering and Technology",Pearson India Education Services Pvt. Ltd, 7th edition, 2018.

REFERENCES:

1.	Mikell P. Groover, "Fundamentals of Modern Manufacturing-Materials, Processes and Systems" Wiley Publications, 7th edition, 2020.
2.	HMT, Production technology, Mc-Graw Hill, 2017.
3.	Paul De Garmo, J.T. Black, and Ronald. A. Kohser, "Material and Processes inManufacturing", Wiley Publications, 12th edition, 2017.
4.	Hajra Choudhury, "Elements of Workshop Technology", Vol.II., Media Promoters,2010.
5.	Geofrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", CRCPress, 2005.

E-RESOURCES:

1.	https://archive.nptel.ac.in/courses/112/105/112105219/
2.	https://archive.nptel.ac.in/courses/112/105/112105233/
3.	https://nptel.ac.in/courses/112105127

4.	https://nptel.ac.in/courses/112104290
5.	https://www.digimat.in/nptel/courses/video/112105211/L11.html
6.	https://archive.nptel.ac.in/courses/112/103/112103248/
7.	http://home.iitk.ac.in/~vkjain/Lecture2-Metalcutting.pdf
8.	http://home.iitk.ac.in/~nsinha/Non-traditional-machining.pdf

COURSE ARTICULATION MATRIX:

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

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

ME22309	INDUSTRIAL METALLURGY: THEORY AND PRACTICES	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

1.	To understand the metallurgy of casting.
2.	To know the basic metallurgy of the weld joints and heat-affected zone of a metal or alloy.
3.	To gain knowledge on powder metallurgy.
4.	To acquire knowledge on microstructure of various metals.

UNIT I	CASTING METALLURGY	12

Introduction to physical and mechanical metallurgy. Introduction to casting processes. Phenomenon of solidification. Microstructure – grains, grain boundaries, dendrites, ASTM grain size, defects like porosity, blowholes, inhomogeneous segregation, and shrinkage. Effects of cooling rate on microstructure of castings. Effects of Microstructure on mechanical properties. Preheat and post heat treatment of castings.

UNIT II	WELDING METALLURGY	12

Welding processes - Transformations in weldments, residual stresses, distortions and defects in arc welding, gas welding, resistance welding, friction stir welding, TIG & MIG welding processes. Significance of phase diagrams for metals and alloys. Weldability issues in ferrous and non-ferrous materials. Introduction to heat affected zones and properties. Concept of solidification in welding. Preheat and post-weld heat treatments.

UNIT III	POWDER METALLURGY	12

Introduction - Powder Fabrication - Different powder fabrication techniques. Powder Characterization. Compressibility and green strength. Powder preparation & powder packing. Phenomenology of Powder Compaction; Influence of Material and Powder Characteristics. Sintering. Micro and macro structure of powder metallurgy products. Applications of powder metallurgy. Case studies on powder-metallurgy products.

UNIT IV	MICROSTRUCTURE STUDIES ON FERROUS MATERIALS	12

Study of metallurgical microscope and scanning electron microscope, Preparation of specimen for microstructural studies, Investigation of microstructure of - Plain carbon steels, heat-treated mild steel and Stainless steel, Welded Joints and Heat affected zone and Cast Steel

UNIT V	MICROSTRUCTURE STUDIES ON NON-FERROUS MATERIALS	12

Investigation of microstructure of Wrought Aluminum, Magnesium alloys and Copper alloys, Super alloys. Grain size & flake size measurement of alloys using image processing technique. Investigation of microstructure of powder sintered components and aluminum castings.

TOTAL: 60 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Interpret the grain size and morphology of different metal castings and relate the	3

	heat treatment and microstructures.	
CO2	Demonstrate the effects of welding on the properties of ferrous and non-ferrous alloys.	3
CO3	Outline the characterization of powder metallurgy materials.	4
CO4	Analyze the microstructure of steels and effect of heat treatment on microstructure.	4
CO5	Analyze the microstructure of aluminum, Magnesium, copper alloys and castings using metallurgical microscope.	4

TEXTBOOKS:

1.	John Campbell, "Complete Casting Handbook: Metal Casting Processes, Metallurgy, Techniques and Design", Butterworth-Heinemann; 2nd edition, 2015
2.	Sindo Kou, "Welding Metallurgy", A John Wiley & Sons, 2nd edition, 2002.
3	Anish Upadhyaya & Gopal Shankar Upadhyaya, "Powder Metallurgy: Science, Technology, and Materials", Universities Press; 1st edition, 2011.

REFERENCES:

1.	R. Balasubramaniam, "Callister's Materials Science and Engineering, 2nd edition, 2014.
2.	George E. Dieter, "Mechanical Metallurgy", McGraw Hill Education; 3rdedition, 2017.
3.	John K. C. "Metal Casting and Joining", PHI Learning Pvt. Ltd, 1st edition, 2015.
4.	Dr. M. Mohandass, "Material Testing and Metallurgy Laboratory Manual", SVCE, 2018.

E-RESOURCES:

1.	https://www.iitg.ac.in/engfac/ganu/public_html/Powdermetallurgy.pdf
2.	https://archive.nptel.ac.in/content/syllabus_pdf/113106098.pdf
3.	Dr. K. Ramesh, "Strength of Materials Laboratory Manual" IITM, 2003.

COURSE ARTICULATION MATRIX

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

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl. No.	**Description of Equipment/Software**	**Qty**
1.	Metallurgical Microscopes	1
2.	Muffle Furnace (1000° C)	1

3.	Image processing software	1
4.	Jomney End-quench apparatus	1

ME22311	MACHINE TOOLS OPERATIONS LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

1.	To impart the practical knowledge in conducting machining operations on various machine tools
2.	To impart skills to interpret a product drawing and identify the appropriate machine tools for the manufacture and assembly of the product

LIST OF EXPERIMENTS

1.	Contour milling using vertical milling machine
2.	Spur gear cutting in milling machine
3.	Helical Gear Cutting in milling machine
4.	Gear generation in hobbing machine
5.	Gear generation in gear shaping machine
6.	Cylindrical grinding
7.	Tool angle grinding with tool and Cutter Grinder
8.	Measurement of cutting forces in Turning Process
9.	Round to square using shaper
10.	Round to hexagon using milling
11.	Drilling and tapping in a radial drilling machine (Practice with and without drill jig)
12.	Machining and assembly of components for the given product diagram using various machine tools
13	Machining of components for clearance/interference fits

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Perform machining operations in shaper and milling machine tools to generate planar surfaces.	3
CO2	Manufacture the single point cutting tool for the given tool signature using tool and cutter grinding	3
CO3	Calculate various force components in lathe machine tool by varying cutting parameters and interpret their influence on the force components during orthogonal cutting	3
CO4	Select appropriate gear manufacturing methods for gear machining	3
CO5	Interpret the given product drawing and chose various machine tools in sequence for the manufacture of various components and assemble the final product for the required fit.	3

REFERENCES: (min 3, max 5)

1.	Serope Kalpakjian & 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.II: Machine tools., Media Promoters & Publishers Pvt Ltd, 2010.

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/
4	https://archive.nptel.ac.in/courses/112/106/112106179/

COURSE ARTICULATION MATRIX:

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

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1.	Horizontal Milling Machine 2 No
2.	Vertical Milling Machine 1 No
3.	Cylindrical Grinding Machine 1 No
4.	Lathe Tool Dynamometer
5.	Gear hobbing machine 1 No
6.	Tool and cutter grinder 1
7.	Gear shaper 1 no
8.	Cylindrical grinding machine 1 no
9.	Universal milling machine 1 no
10.	Lathe machine 5 Nos

ME22312	MECHANICS OF MATERIALS LABORATORY	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 with practical testing for determining the strength of materials under externally applied different forms of load.
2.	To enable the students to evaluate the strengths, hardness, and stiffness of the metallic materials.

LIST OF EXPERIMENTS

Tension test on a mild steel rod

Double shear test on Mild steel and Aluminum rods

Torsion test on mild steel rod

Impact test on mild steel specimen (Charpy & Izod)

Hardness test on metals – Vickers Micro-hardness, Brinell and Rockwell Hardness Number

Deflection test on beams (Simply supported and Cantilever)

Compression test on helical springs

Comparison of Mechanical properties of steel using impact test.
i. Unhardened specimen
ii. Quenched Specimen
iii. Quenched and tempered specimen

Comparison of Mechanical properties of steel using hardness test.
i. Unhardened specimen
ii. Quenched Specimen
iii. Quenched and tempered specimen

Hardenability test of steel using Jomney end quench method.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to		
CO1	Determine the various mechanical properties like hardness, strength (yield, ultimate, fracture), impact using Rockwell & Brinell hardness tester, universal testing machine and impact testing machine respectively.	3
CO2	Evaluate the Young's modulus of steel & aluminum beams using simply supported and cantilever methods.	3
CO3	Evaluate the stiffness and spring index of alloy spring steel using compression test.	3
CO4	Analyze the medium carbon steel hardenability using Jomney end-quench testing.	4

REFERENCES:

1.	Strength of materials laboratory manual.
2.	IS1786-2008, specification for cold worked steel high strength deformed bars for concrete reinforcement, 2008.

E-RESOURCES:

1.	https://sm-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	3
1	3				3				3				3		
2	3				3				3				3		
3	3				3				3				3		
4	3				3				3				3		

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S. No.	Description of Equipment	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 (800^{o}C)	1
8.	Vickers Micro Hardness Tester	1
9.	Deflection (Beam) testing setup – Simply Supported & Cantilever	1
10.	Jomni End Quench Test Setup	1

IV SEMESTER

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

OBJECTIVES:

1.	To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize the biodiversity of India and its conservation.
2.	To impart knowledge on the causes, effects and control or prevention measures of environmental pollution.
3.	To study and understand the various types of renewable sources of energy and their applications.
4.	To familiarize the concept of sustainable development goals, economic and social aspects of sustainability, recognize and analyze climate changes, and environmental management challenges.
5.	To inculcate and embrace sustainability practices, develop a broader understanding of green materials and energy cycles, and analyze the role of sustainable urbanization.

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 pollution. Marine and thermal pollution - causes, effects, and control measures. Light and noise pollution - effect on flora and fauna. Nuclear pollution- Sources, effects, and control measures. Disposal of radioactive wastes (Nuclear hazards). Pollution case studies. Role of an individual in the 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 types of 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-economic and technological change. Rainwater harvesting, watershed management, environmental ethics: Issues and possible solutions.

CO No	**COURSE OUTCOMES:**	**RBT LEVEL**
After completion of this course, the learners will be able to		
CO 1	Recognize the fundamental role of ecosystems and suggest an appropriate method for the conservation of biodiversity.	3
CO 2	Describe the different types of pollution, their effects and strategies to control pollution.	3
CO 3	Identify the various renewable energy resources and use the appropriate one thereby conserving non-renewable resources for future generation.	3
CO 4	Explain the various goals of sustainable development applicable to suitable technological advancement and societal development.	2
CO 5	Summarize the various sustainability practices, green materials, energy cycles, and the role of green engineering in sustainable urbanization.	2

TEXTBOOKS:

1.	Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 7th Edition, New Age 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, Pearson. 2011.
5.	Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, CL Engineering, 2015.
6.	Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7.	Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

REFERENCE BOOKS:

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.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3					3	3	2		2		1			
CO2	3					3	3	2		2		2			
CO3	3		1			3	3	1		2		1			
CO4	3					3	3	3		2		2			
CO5	3					3	3	3		2		2			

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

ME22401	FLUID MECHANICS	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES:

1.	To make students to understand the Fluid properties.
2.	To make students to calculate the flow.
3.	To make students to calculate the interaction of compressible flow and incompressible flow.
4.	To make students to do dimensional and model analysis.

UNIT I	FLUID PROPERTIES AND STATICS	9

Introduction to Fluid Properties and Statics: Fluids and continuum, Physical properties of fluids, Newton's law of viscosity. Ideal and real fluids, Newtonian and non - Newtonian fluids. Other transport properties of fluids. Pressure Measurements, Manometry. Fluid Statics-Pressure-density-height relationship. Hydrostatic forces on a plane and a curved surface. Buoyancy, Flotation and Stability.

UNIT II	FLUID KINEMATICS	9

Types of Motion and deformation for a fluid element. Velocity field – Eulerian and Lagrangian flow description, Classification of fluid flow streamline, path line and streak lines, Acceleration field. Introduction to steam function. Velocity potential and potential function. Divergence and Curl, Vorticity, Control Volume and System representations, Reynolds transport theorem.

UNIT III	FUNDAMENTALS OF FLUID DYNAMICS	9

Elementary Fluid dynamics – Euler and Bernoulli's Equations and their applications; Restrictions on the use of Euler and Bernoulli's Equations. Differential and Finite control volume approach for the fluid flow. Inviscid and incompressible flow- Some basic planes and potential flows and their superposition. Viscous flow – Simple viscous and incompressible flows. Flow over immersed bodies-Prandtl/Blasius Equation – Prandtl/Blasius Boundary Layer solutions. Flow in pipes – Major and Minor losses – Darcy Weisbach Equation – Moody diagram - Flow in series and parallel pipes and pipe networks. Hydraulic and Energy gradient lines.

UNIT IV	FUNDAMENTALS OF COMPRESSIBLE FLOW	9

Ideal Gas relationship-Mach Number and Speed of sound – Isentropic flow of an Ideal Gas – Effect of Variation in flow cross section – Converging and diverging duct flow- Constant area duct flow.
Non-Isentropic flow – Fanno and Rayleigh flows. Flow with shock – Normal shocks. (Only qualitative treatment)

UNIT V	SIMILITUDE, DIMENSIONAL ANALYSIS AND MODELING	9

Dimensional Analysis – Buckingham Pi theorem – Common dimensionless groups in fluid mechanics. Correlation of experimental data. Modelling and similitude – Theory of models and Model scales. Practical aspects of Using Models.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level

At the end of the course, learners will be able to:		
CO1	Calculate the various properties of the fluids using fundamental relationships and calculate the hydrostatic forces on the submerged objects.	3
CO2	Calculate and draw the velocity and acceleration field vectors by knowing the potential and/or stream functions and apply the Reynolds Transport theorem.	3
CO3	Calculate the forces acting on the various surfaces and pressure drop in the flow.	3
CO4	Calculate the flow parameters in a compressible fluid flow.	3
CO5	Perform Dimensional analysis and model analysis.	3

TEXTBOOKS:

1.	Bruce R. Munson, Theodore H. Okiishi, Wade W. Huebsch, Alric P. Rothmayer Fundamentals of fluid mechanics - John Wiley & Sons, Inc. 7th Edition – 2013.
2.	Modi P.N., and Seth S.M., "Hydraulics and Fluid Mechanics Including Hydraulic Machines (In SI Units) – 21st Edition - 2017

REFERENCES:

1.	Frank m. White Henry Xue – Fluid Mechanics – McGraw-Hill Education 9th edition 2022
2.	John Anderson, Fundamentals of Aerodynamics- McGraw-Hill Education, 2 Penn Plaza, New York, NY 10121 6th Edition 2017
3.	Victor Streeter, E. Benjamin Wylie, K.W. Bedford - Fluid Mechanics – Indian edition 2017
4.	Philip J. Pritchard Fox and Mcdonald's Introduction To Fluid Mechanics – John Wiley & Sons, Inc. 8th Edition - 2011
5.	Yunus A. Cengel, John M. Cimbala - Fluid Mechanics - 4th Edition - 2017

E-RESOURCES:

1.	https://nptel.ac.in/courses/112104118
2.	https://nptel.ac.in/courses/105103192
3.	E Resource: https://archive.nptel.ac.in/courses/112/105/112105171/
4.	https://nptel.ac.in/courses/112105269

COURSE ARTICULATION MATRIX:

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

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

ME22402	KINEMATICS OF MACHINERY	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES:

1.	To study the basic components of mechanisms, analyzing the mechanisms with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism.
2.	To acquire knowledge about basic approach to solve forward Kinematics of one DOF planar robot.
3.	To design the cam profile for specified output motions and to study the gear parameters.
4.	To learn the effects of friction and its influence in machine elements.

UNIT I	KINEMATICS OF MECHANISMS	9

Mechanisms – Terminology and definitions –Mobility and range of movement - Kutzbach and Grubler's criterion, Grashof's criterion. Kinematics inversions of four bar and slide crank chain –Description of some common mechanisms – Quick return mechanisms, Straight line generators - Equivalent mechanisms.

UNIT II	KINEMATICS SYNTHESIS AND ANALYSIS	9

Synthesis - Number Synthesis, Dimensional synthesis of mechanism; motion, path and function generation, precision point approach, Chebyshev spacing.

Analysis of simple mechanisms - Single slider crank mechanism and four bar mechanism – Graphical Methods for finding velocity, and acceleration using velocity and acceleration polygons.

Coriolis Component of acceleration in Shaping machine mechanism. Instantaneous Centre of Velocity.

UNIT III	ROBOT KINEMATICS	9

Introduction to Robotics – Terminologies – Classifications. Overview – Links & Joints - Degrees of Freedoms – Coordinate System - Roll, Pitch and Yaw Angles - Need for forward and Inverse Kinematics Equation — Methods of forward and inverse kinematics for one degree of freedom of a Planar Robot.

UNIT IV	GEAR, GEAR TRAINS AND CAMS	9

Gears – law of toothed gearing – Involute gearing – Gear tooth action- interference and undercutting – minimum number of teeth, contact ratio.

Gear trains – Speed ratio of simple gear train, reverted gear train, compound gear train and epicyclic gear trains.

Classification of followers and cams, Terminology, and definitions – Displacement diagrams –Uniform velocity and simple harmonic motions.

UNIT V	FRICTION IN MACHINE ELEMENTS	9

Surface contacts – Types of friction – Friction drives – Friction in screw threads – Friction in clutches – Friction aspects in brakes.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to		
CO1	Classify the mechanisms involved in various applications.	3
CO2	Select, configure, and synthesize linkages into complete mechanisms.	3
CO3	Apply the concept of kinematics for robot motion control.	3

CO4	Calculate the relevant kinematic parameters of cam and gear mechanisms.	3
CO5	Apply the concepts of friction in real time applications.	3

TEXTBOOKS:	
1.	Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press, 2017
2.	Ramamurthi. V, "Mechanics of Machines", Narosa Publishing House, 3rd Edition, 2019
3.	Mikell P. Groover, "Industrial Robotics", McGraw Hill, 2nd Edition, 2018
4.	John J. Craig, "Introduction to Robotics", 4th Edition, Pearson 2017

REFERENCES:	
1.	K. J, Waldron and G. L Kinzel, Sunil K. Agrawal, Kinematics, Dynamics and Design of Machinery, 3rd Edition, Wiley Student Edition, 2016.
2.	Rao.J.S. and Dukkipati.R.V. "Mechanism and Machine Theory", New Age International Pvt. Ltd., 2nd Edition, 2014
3.	Rattan, S.S, "Theory of Machines", McGraw-Hill Education Pvt. Ltd., 5th Edition, 2019.
4.	R. L. Norton, Kinematics and Dynamics of Machinery, Tata Mcgraw Hill, 2017.
5.	Lynch, Kevin M., and Frank C. Park. Modern Robotics: Mechanics, Planning, and Control 1st Edition, Cambridge University Press, 2017.

E-RESOURCES:	
1.	https://onlinecourses.nptel.ac.in/noc20_me21
2.	https://onlinecourses.nptel.ac.in/noc22_me108
3.	https://archive.nptel.ac.in/noc/courses/noc21/SEM1/noc21-me08
4.	http://www.roboanalyzer.com

COURSE ARTICULATION MATRIX:

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

MN22408	HYDRAULICS AND PNEUMATICS FOR AUTOMATION: THEORY AND PRACTICES (Common to MN and 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 and analyze 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, performance and selection. Hydraulic actuators – linear & rotary. Control components – directional, flow and pressure control valves - types, working principle and applications. Electro-hydraulic circuits. Servo systems.

UNIT II PNEUMATIC SYSTEM COMPONENTS **09**

Compressors - types and working principle. Filter, Regulator, Lubricator, Muffler, Air control valves, Quick exhaust valves, Pneumatic actuators, Servo valves. Fluid power ANSI symbol. Electronics in automation – PLC and Micro controller. Electro-pneumatic circuits.

UNIT III FLUID POWER ACCESSORIES AND MAINTENANCE **10**

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. Low-cost automation.

LABORATORY COMPONENT

LIST OF EXPERIMENTS

1. Design of pneumatic circuit using cascade method
2. Design of electro-pneumatic circuits using electrical timers and counters
3. Design of pneumatic circuit using Programmable Logic Controller (PLC)
4. Design of hydraulic circuit for synchronizing the linear actuators
5. Design of hydraulic circuit for controlling rotary actuators
6. Design of hydraulic circuit using Programmable Logic Controller (PLC)
7. Design and simulation of meter-in and meter-out circuits
8. Design and simulation of pump unloading circuit
9. Design and simulation of counterbalance circuit
10. Design and simulation of cascade circuits

TOTAL: 60 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners 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 fluid power circuit using various controls for different industrial applications	3
CO5	**Simulate** and **analyze** fluid power circuits using software tools	4

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:	
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 McGraw Hill, 2007
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.
6.	Mechatronics training practice module, FESTO manual Germany, 2011.
7.	Automation Lab Manual prepared by Faculty of Mechanical Engineering, Sri Venkateswara College of Engineering.

E-RESOURCES:	
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			3	3
5	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

S.No.	Item Description	Quantity
1.	Basic pneumatic trainer kit	1 No.
2.	Electro pneumatic trainer kit	1 No.
3.	Electro pneumatic trainer kit with PLC	1 No.
4.	Basic hydraulic trainer kit	1 No.
5.	Electrohydraulic trainer kit with PLC	1 No.
6.	Automation studio software	5 Licenses
7.	Fluidsim software	5 Licenses
8.	Personal computers	10 No.
9.	Compressor – 10 bar	1 No.

ME22409	DESIGN THINKING: THEORY AND PRACTICES	L	T	P	C
		1	0	2	2

COURSE OBJECTIVES

1.	To understand the concept of design thinking and define the problems effectively.
2.	To develop skills in ideation, prototyping, and user feedback.
3.	To develop skills in testing, finalizing designs, and overcoming resistance.
4.	To apply design thinking in business/startup, validate solutions, and develop team project skills while considering ethical and social needs.

UNIT I DESIGN THINKING PROCESS AND TOOLS 12

A brief insight to design thinking and innovation - people centered design & evoking the right problem - Purpose of design thinking - design thinking framework, design thinking process, design thinking tools, Empathy - Uncovering and investigating community concerns - Define: Examine and Reflect on the problem.

UNIT II CONCEPT GENERATION AND BUILDING 11

Design team-Team formation, Conceptualization: Visual thinking, Sketching/Drawing, new concept thinking, Concept Generation Methodologies, Concept Selection, Concept Testing, Opportunity identification Prototyping: Principles of prototyping, Prototyping technologies. Patents and Intellectual Property.

UNIT III TEST, REFINE AND PITCH IDEAS 12

Importance of testing, Testing the design with people - Retest and Redefine Results - Creating a pitch for the design.

UNIT IV VALUE PROPOSITION DESIGN 10

Business Vs Startup - Briefing the problem - Problem Validation and user discovery - Briefing the Challenges.

TOTAL: 45 PERIODS

Guidelines

- Two assignments, two seminars and two Formative assignment tests are mandatory.
- All the students enrolled for this course must do design project work based on design thinking strategies.
- The team should submit a project report as documents at the end of the semester.
- A maximum of 3 students are permitted in a team.

End semester:

End semester examination will be conducted as VIVA VOCE by presenting the project work carried out by the students.

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Understand design thinking principles and empathize with users to define the problem.	2
CO2	Generate and evaluate ideas, develop prototypes, and iterate based on user feedback.	4
CO3	Evaluate prototype effectiveness, finalize the design, and develop implementation strategies.	4
CO4	Apply design thinking in business/startup, validate solutions, and present/implement final design.	4

TEXTBOOKS:	
1.	Idris Mootee, Design thinking for strategic innovation, Wiley publications, 2013.
2.	Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, HarperCollins Publishers Ltd, 2009.
3.	Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand – Improve – Apply", Springer, 2011.
REFERENCES:	
1.	Ulrich & Eppinger, Product Design and Development, 3rd Edition, McGraw Hill, 2004.
2.	Michael Lewrick, Patrick Link, and Larry Leifer, The Design Thinking Playbook: Mindful Digital Transformation of Teams, Products, Services, Businesses and Ecosystems, 2018, John Wiley & Sons.
3.	Tom Kelley, The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm, Currency/Doubleday, 2001.
4.	Kevin Otto, Kristin Wood, Product design, Pearson publications, 2001.
5.	George Dieter, Linda Schmidt, Engineering Design, McGraw Hill, 2012.
E-Resources:	
1.	Design & Thinking Documentary, https://nyu.kanopy.com/video/design-and-thinking.
2.	Christian Bason and Robert D. Austin, The Right Way to Lead Design Thinking.
3.	Jon Kolko, Design Synthesis.
4.	Dr. Ashwin Mahalingam, Prof. Bala Ramadurai, Design Thinking - A Primer, IIT Madras.
5.	Lee-Sean Huang, Innovate with Design Thinking audio course, https://knowable.fyi/courses/innovate-design-thinking/
6.	https://www.academia.edu/24919250/Understanding_the_behaviour_of_design_thinking_in_complex_environments

COURSE ARTICULATION MATRIX

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

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

ME22411	COMPUTER AIDED MODELING LABORATORY (Common to ME and 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, Blend and Parametric modeling-conversion of STL format.
3.	Surface modeling: Extrude, Sweep, Trim, Mesh of curves and Free form.
4.	Create a surface model of Aero Foil / Blower upper housing / Bend Pipe with flange.
5.	Construct a three-dimensional assembly model of Flange Coupling. **
6.	Construct a three-dimensional assembly model of Screw Jack. **
7.	Create a three-dimensional assembly model of Universal Coupling. **
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.

****Drafting of standard assembly elements into Orthographic, Isometric and Sectional views with Bill of Materials.**

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.	4
CO2	Create a 3D assembly in the assembly module using the 3D parts created in the part modeling module.	4
CO3	Generate 2D detail drawing for the given parts & assembly models.	4
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	3
1					3				2	2			2		
2					3				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

1.	**Windows 10 64-bit, 4GB or higher**
2.	**PTC Creo parametric**

ME22412	FLUID AND THERMAL ENGINEERING LABORATORY (Common to ME and MN)	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

1.	To gain hands on experience in flow measurements using different devices.
2.	To calculate the frictional loss in pipes.
3.	To study the performance characteristics of pumps and turbines.
4.	To study the performance characteristics of diesel engine and compressor.
5.	To study the properties of fuels/lubricants used in IC Engine.

LIST OF EXPERIMENTS

1.	Determination of the Coefficient of discharge of given Venturi meter 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.	Port timing and Valve timing diagram of two and four stroke Engine.
9.	Performance test on diesel engine
10.	Performance test on air compressor
11.	Heat Balance test on Diesel Engine
12.	Retardation test on Diesel Engine

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Use the flow measurement equipment.	3
CO2	Analyze the performance of various pumps.	4
CO3	Analyze the performance of various turbines.	4
CO4	Analyze the performance of diesel engine and compressors.	4
CO5	Calculate the viscosity, flash & 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.	Rajput. R.K., "Thermal Engineering", Laxmi Publications, Tenth Edition, 2017
4.	Ganesan, V "Internal Combustion Engines", fourth Edition, Tata McGraw-Hill, 201

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

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1.	Venturi meter setup and Orifice meter setup
2.	Pipe Flow analysis setup
3.	Centrifugal pump setup
4.	Reciprocating pump setup
5.	Gear pump setup
6.	Pelton wheel setup
7.	Apparatus for Flash and Fire Point and viscometer
8.	4-stroke Diesel Engine with hydraulic loading
9.	Four Stroke Diesel Engine with Mechanical Loading
10.	Steam Boiler setup
11.	Air compressor
12.	Cut Section model of two stroke and Four Stroke Engine

ME22413	COMPREHENSION I	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

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- To provide a complete review of Mechanical Engineering topics covered in second, third and Fourth semesters so that a comprehensive understanding is achieved.
- To strengthen the students in fundamentals pertaining to core courses
- To make the students to face job interviews, competitive examinations and to enhance the employment potential

CONTENTS

1.	Fundamentals of Engineering drawing
2.	Fundamentals of Engineering Mechanics
3.	Basics of Geometric Dimensioning and Tolerancing
4.	Basics of Metal forming processes
5.	Basics of Metal Machining processes
6.	Fundamentals of Thermodynamics
7.	Fundamentals of Strength of Materials
8.	Fundamentals of Thermal Engineering

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Understand and strengthen the fundamentals in Engineering science courses	3
CO2	Understand and strengthen the fundamentals in Professional core courses	3

Evaluation

After revising the fundamentals, a Multiple-Choice questions-based test will be conducted every week in each subject. The grade will be awarded based on the score secured by the students in each subject.

COURSE ARTICULATION MATRIX:

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

V SEMESTER

ME22501	DYNAMICS OF MACHINERY	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES

1.	To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms.
2.	To understand the undesirable effects of unbalances resulting from prescribed motions in mechanism.
3.	To understand the effect of Dynamics of undesirable vibrations.
4.	To understand the principles in mechanisms used for speed control and stability control

UNIT I	FORCE ANALYSIS	9

Dynamic force analysis – Inertia force and Inertia torque– D Alembert's principle –Dynamic force analysis in IC Engine– Turning moment diagrams –Fluctuation of energy and speed, Determination of weight of Flywheel required based on fluctuation of energy – Punching press.

UNIT II	BALANCING OF MASSES	9

Dynamic balancing – Balancing of rotating masses under single and several planes – Balancing of reciprocating masses - Primary and secondary forces and couples.

UNIT III	FREE VIBRATION	9

Basic features of vibratory systems – Degrees of freedom – Single degree of freedom – Free vibration – Equations of motion – Natural frequency – Types of damping – Damped vibration– Critical speeds of shafts – Dunkerley method. Torsional vibration – Natural frequency of stepped shaft.

UNIT IV	FORCED VIBRATION AND MEASUREMENT	9

Response of one-degree freedom systems to periodic forcing – Disturbance caused by unbalance – Support motion –transmissibility – Vibration isolation.
General considerations in vibration measurement - Vibration pickups.

UNIT V	CONTROL MECHANISMS	9

Governors – Types – Centrifugal governors –Watt, Porter and Proell Governor, Electronic Governor-working principle and applications.
Gyroscopes –Gyroscopic forces– Gyroscopic effects in Automobiles, Ships and Airplanes.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Calculate dynamic forces acting on IC engine and determine the mass of the flywheel for the given industrial requirement.	3
CO2	Balance the reciprocating and rotating masses by appropriately calculating the required masses and orientation for balancing.	3
CO3	Compute the frequency of free vibration and damping coefficient.	3
CO4	Evaluate the transmissibility under forced vibration and in turn provide solutions for vibration isolation.	3
CO5	Apply the controlling effect of Gyroscopes and Governors in real time applications.	3

TEXTBOOKS:	
1.	Rao, S.S, “Mechanical Vibrations,” Pearson Education, Fifth Edition, 2011.
2.	Rattan, S.S, “Theory of Machines”, Tata McGraw-Hill, Fourth Edition, 2017.
3.	Sadhu Singh, “Theory of Machines: Kinematics and Dynamics”, Pearson Education, Third edition, 2011.
4.	Uicker, J.J., Pennock G.R and Shigley, J.E., “Theory of Machines and Mechanisms”, Oxford University Press, Fifth Edition,2017.
REFERENCES:	
1.	Ghosh. A., and Mallick, A.K., “Theory of Mechanisms and Machines", East-West Pvt. Ltd., New Delhi, 2008.
2.	Grover. G.T., “Mechanical Vibrations”, Nem Chand and Bros., 2009
3.	Khurmi, R.S., “Theory of Machines”, S Chand Publications, 2005.
4.	RaoJ.S. and DukkipatiR.V. "Mechanisms and Machine Theory", Wiley-Eastern Ltd., New Delhi, 1992.
5.	Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 2009.
E-Resources:	
1.	https://nptel.ac.in/courses/112104114/
2.	https://freevideolectures.com/course/2364/dynamics-of-machines/
3.	https://cosmolearning.org/courses/dynamics-of-machines/
4.	https://www.edx.org/course/machine-dynamics-with-matlab-3/

COURSE ARTICULATION MATRIX

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

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

ME22502	FAILURE ANALYSIS AND PREVENTION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1.	The course content is designed to systematic understanding on various aspects related with failure such as fundamental sources of failure of mechanical components, industrial engineering tools relevant to failure and failure analysis.
2.	At the end of this course, the student is expected to perform failure analysis with the use of fracture mechanics and fracture toughness principles in failure analysis and prepare the analysis findings and prepare the report/recommendations.

UNIT I	ENGINEERING ASPECTS OF FAILURE AND FAILURE ANALYSIS	9

Overview of Failure Analysis - Failure modes - Failure analysis - General practice in failure analysis- Categories of failure- Need and scope of failure analysis and prevention- Fundamental sources of failures: Deficient design, Imperfections in base metals, Improper manufacturing, improper service conditions, Poor assembly, service and maintenance.

UNIT II	TOOLS AND TECHNIQUES IN FAILURE ANALYSIS	9

General practices, Photography, X-rays techniques, Mechanical property evaluations, Metallographic techniques, Fractography.

Industrial engineering tools for failure analysis: Pareto diagram, Fishbone diagram and Fault tree analysis. General procedure of failure analysis: Steps, Background information collection and Preliminary examination.

UNIT III	FAILURE MECHANISMS AND MODES	12

Fracture modes, Ductile fracture of metallic materials and their interpretations, factors affecting ductile-brittle relationships- Brittle fracture in normally ductile metallic alloy, microstructural aspects of brittle fracture - Failure characteristics of Ceramics and Plastics - Fatigue fracture, macroscopic and microscopic characteristics, - Wear Failures and Prevention - Corrosion related failures, Stress corrosion cracking, Hydrogen damage and embrittlement, Biological corrosion failures- Elevated temperature failures, creep and stress rupture - Metallurgical instabilities - Distortion failures and deformations.

UNIT IV	EXAMPLES OF ENGINEERING FAILURE	8

Improper processing practice: Casting, metal working, welding - Improper heat treatment: Gears, locomotive axle, shafts - Improper design: Tools and dies. Improper material selection: Pressure vessels - Improper service condition: Pipelines, mechanical fasteners. Unanticipated service conditions: Lifting equipment, reactors, gear and bearing failure.

UNIT V	COMPREHENSIVE FAILURE ANALYSIS ILLUSTRATION	7

At least two cases based on automobile, aircraft crash, ship sinking, boiler blast, space mission failure, industrial catastrophe.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Understand the importance of failure analysis in identifying root causes and implementing preventive measures to enhance product reliability and safety.	2
CO2	Examine the general procedure of failure analysis, background information collection and	3

	preliminary examination, to identify potential causes and develop appropriate investigation strategies.	
CO3	Investigate factors influencing ductile-brittle transition and brittle fracture in normally ductile metallic alloys, with focus on micro structural aspects.	3
CO4	Analyze failures resulting from improper design considerations, including tools and dies, and their impact on performance and reliability.	4
CO5	Analyze the root causes for the incidents using comprehensive failure reports and records.	4

TEXTBOOKS:

1.	Charles R. Brooks and Ashok Choudhury, Failure analysis of Engineering Materials, Mcgraw Hill Publications, 2002.
2.	V. Ramachandran, A.C. Raghuram, R.V. Krishnan and S.K. Bhaumik, Failure analysis of engineering structures: Methodology and case histories, ASM International,2005.

REFERENCES:

1.	D.J Wulpi, Understanding how components fail, ASM International, The Materials Information Society, 1999.
2.	Layer, J. & Adler, T. & Ahmed, R. & Aliya, Debbie & Antolovich, Stephen & Baggerly, R.G. ASM handbook-failure analysis and prevention. ASM international, 2002.
3.	A.J. McEvily, Metal Failures: Mechanisms, Analysis, Prevention, John Wiley and Sons,2002.
4.	Failure analysis and prevention, Volume 11, ASM Handbook, The Materials InformationSociety, 2002.
5.	H.M. Tawancy, A. Ul-Hamid and N.M. Abbas,Practical engineering failure analysis, Marcel Dekker, New York, 2004.

E-Resources:

1.	https://nptel.ac.in/courses/112107241
2.	https://nptel.ac.in/courses/112106072

COURSE ARTICULATION MATRIX

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

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

ME22503	HEAT AND MASS TRANSFER	L	T	P	C
		3	1	0	4

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 dropwise 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	12

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 with and without heat generation – 1D Extended surfaces – Introduction to 2D steady state without heat generation – Transient heat conduction – lumped system analysis only. Semi Infinite and Infinite Solids – Use of Heisler's charts – Methods of enhanced thermal conduction

UNIT II	CONVECTION	12

The Convection Boundary Layers - Local and Average Convection Coefficients - Laminar and Turbulent Flow - The Boundary Layer Equations - Boundary Layer Similarity: The Normalized Boundary Layer Equations - 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: Enclosures.

UNIT III	BOILING AND CONDENSATION HEAT TRANSFER AND HEAT EXCHANGERS	12

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).

Heat Exchanger Types – TEMA standard -The Overall Heat Transfer Coefficient – Fouling factors - Heat Exchanger Analysis: Use of the Log Mean Temperature Difference (LMTD) and The Effectiveness – Number of transfer units (NTU) Method.

UNIT IV	RADIATION HEAT TRANSFER	12

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 – Shape factor - Electrical analogy – Radiation shields – Gas Radiation.

UNIT V	MASS TRANSFER	12

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state and Transient Diffusion -

Stefan flow – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.	
TOTAL: 60 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 and also understand the approach to calculate the two-dimensional heat transfer	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	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	Calculate the radiation heat transfer between real surfaces and between a surface and a gas (CO_2 and H_2O)	3
CO5	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.
4.	Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 1998
5.	Sachdeva, R.C. Fundamentals of Engineering Heat Transfer, New Age Science Ltd., New Delhi; 4th edition, 2009.
6.	Kothandaraman, C.P., “Heat and Mass Transfer data book", New Age International, New Delhi, 2022.

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

ME22504	MACHINE COMPONENTS DESIGN	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES

1.	To impart knowledge on the design principles of compounding stress, static and fatigue loading.
2.	To instill the knowledge on safe stress and corresponding size of shafts, keys, and couplings and the practices of standards, fits, and tolerances.
3.	To inculcate the design principles of bearings.
4.	To familiarize the design principles of riveted, welding structures and principles of energy storing elements.

UNIT I	DESIGN PRINCIPLES OF COMBINED AND VARYING STRESSES IN MACHINE ELEMENTS	10

Design processes – types of loads and stress equations- eccentric loading -principle stresses for various load combinations, Factor of Safety, theories of failure – design based on strength and cyclic stress endurance limit and strength, S-N curves, factors affecting the life of the machine components -Goodman and Soderberg's relationship- simple problems-concept of stress due to combined loading.

UNIT II	DESIGN OF SHAFT, KEYS AND COUPLINGS	10

Design principle of shaft - shaft subjected to combined twisting and bending moment only, design of keys, design of rigid coupling and flexible coupling. standards- fits and tolerance – simple problems.

UNIT III	DESIGN OF BEARINGS	9

Bearing- classification- rolling and sliding- failures in bearings-sliding- Journal bearing- nomenclature- hydrodynamic- hydrostatic- design of hydrodynamic journal bearing- Sommerfeld number- rolling contact bearing- nomenclature- design principle and selection of rolling contact bearing.

UNIT IV	DESIGN OF TEMPORARY AND PERMANENT JOINT	8

Introduction-temporary joints – riveting procedure – design of eccentrically loaded structural riveted joints. permanent joint- welding- symbols- joint types- design principles - eccentrically loaded welded structure.

UNIT IV	DESIGN OF ENERGY STORING ELEMENTS	8

Introduction- springs- flywheel- types of springs- design principles - close coil helical springs under static load - leaf spring – nipping - design of leaf spring.

TOTAL: 45 PERIODS

Guidelines (If any)

Use of PSG Design Data book is permitted in the examinations.

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	**Analyze** the failure of machine elements under combined and cyclic stress.	4
CO2	**Compute** the critical size and safety of shaft, key, and couplings and also evaluate the fits and tolerance.	4
CO3	**Apply and analyze** the design procedure for supporting machine member.	4
CO4	**Apply and analyze** the rivets and welded joints for suitable structural applications.	4

CO5	**Implement** the design procedure for designing the spring and its critical parameters	4

TEXTBOOKS:	
1.	Bhandari,V.B, "Design of Machine Elements", Fifth edition, McGraw Hill, 2020 .
2.	Khurmi, R.S, " A Text book of Machine Design", 25th edition, S. Chand publication,2020
3.	Sadhu Singh, "Design of Machine Elements (Machine Design)", 2014th edition, Khanna Publishing, 2019.
REFERENCES:	
1.	Deutschman, D & Wilson, C.E., "Machine Design Theory & Practice," Macmillan, 1992
2.	Hall, Holowenko and Laughlin, "Machine Design", Special Indian Edition, TMH, 2008.
3.	Juvinal, R.C, "Fundamentals of Machine Component Design," John Wiley, 1994.
4.	Norton, R.L, "Mechanical Design – An Integrated Approach," Prentice Hall, 2011.
5.	Richard G. Budynas, J.KeithNisbett, " Shigley's Mechanical Engineering Design", 10th edition, TMH, 2015.
6.	Sadhu Singh, "Machine Design Data Book", Khanna Book Publishing, 2022.
7.	Spottes, M.F., "Design of Machine Elements," Prentice-Hall India, 1994.
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	3
1	**3**	**3**	**1**						**1**			**1**	**3**		
2	**3**	**2**	**1**						**1**			**1**	**3**		
3	**3**	**2**	**1**						**1**			**1**	**3**		
4	**3**	**2**	**1**						**1**			**1**	**3**		
5	**3**	**2**	**1**						**1**			**1**	**3**		

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

ME22511	Dynamics and Vibrations Laboratory	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

1.	To supplement the principles learnt in kinematics and Dynamics of Machinery.
2.	To impart the knowledge on measuring devices used for dynamic and vibration testing environment.

STUDY EXPERIMENTS: (Excluded for Examination)

1.	Study on Forces acting in Four bar Mechanism using Virtual laboratory, NITK
2.	Study on the Determination of Speed Using Stroboscope and Tachometer (both Contact and Non-contact)

LIST OF EXPERIMENTS:

1.	Determination of Mass moment of inertia and Radius of Gyration of Fly wheel and Axle system
2.	Determination of Mass Moment of Inertia and Gyration of Symmetric bodies using Turn Table apparatus
3.	Determination of Mass Moment of Inertia and Radius of Gyration using Bifilar suspension
4.	Determination of Mass Moment of Inertia and Radius of Gyration using Trifilar Suspension
5.	Determination of Mass Moment of Inertia and Radius of Gyration using compound pendulum
6.	Motorized gyroscope – Study of gyroscopic couple effect
7.	Governor - Determination of range sensitivity, effort etc., for Watts, Porter, Proell, and Hartnell Governors. (Any two Governor).
8.	Cams – Cam profile drawing and study of jump phenomenon
9.	Verification of Torsion equilibrium using Epicyclic Gear Train
10.	Balancing of rotating masses
11.	Single degree of freedom Spring Mass System – Determination of natural Frequency
12.	Determination of torsional natural frequency of single Rotor systems under Undamped and Damped condition.
13.	Whirling of shafts – Determination of critical speeds of shafts
14.	Transverse vibration of Free-Free beam – with concentrated masses using Dunkerley's Principle.
15.	Forced Vibration of Cantilever beam under damped and undamped conditions
16.	Determination of material damping under Free Vibration condition using standard Impulse hammer test.

Guideline: From the above listed Sixteen experiments, considering the aim and measuring parameter as a guideline, ten experiments can be prioritized and framed for a semester.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to		
CO1	Demonstrate the principles of dynamics of machinery.	3
CO2	Utilize measuring devices for dynamic testing.	3
CO3	Use the vibration measuring tools in the related applications.	3

REFERENCES:

1.	Laboratory Manual Prepared by Department of Mechanical Engineering, SVCE

E-resources:

1.	https://dom-nitk.vlabs.ac.in/
2.	https://archive.nptel.ac.in/courses/112/104/112104114/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1.	3	2	2						3				3		
2.	3	2	2						3				3		
3.	3	2	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	QUANTITY
1.	Vibration Setup - Free and Forced vibration setup.	1
2.	Universal Governor Apparatus	1
3.	Determination of natural Frequency by Dunkerley method.	1
4.	Fly wheel and Axle system.	1
5.	Bifilar Suspension	1
6.	Trifilar Suspension	1
7.	Motorized Gyroscope	1
8.	Compound Pendulum	1
9.	Epicyclic Gear Train	1
10.	Whirling of shaft test rig.	1
11.	Cam Analysis Machine	1
12.	Torsional Vibration - Two Rotor systems under Undamped condition	1
13.	Torsional Vibration – Single Rotor systems Damped condition.	1
14.	Fly wheel Setup.	1
15.	Dynamic Balancing Machine – Rotating masses	1
16.	Four Bar Mechanism	1
17.	Universal Joint, Single & Double	1
18.	Spur Gear Train Model	1
19.	Differential Gear train model	1
20.	Stroboscope	1
21.	Digital Tachometer	2
22.	Non-Contact tachometer	2
23.	Electronics Weighing Scale	1

ME22512	Heat Transfer, Refrigeration and Air Conditioning Laboratory	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

1.	To familiarize the students to apply conduction, convection and radiation heat transfer concept to practical application.
2.	To study the performance of refrigeration and air conditioning system/components/cycle

LIST OF EXPERIMENTS:

I HEAT TRANSFER LAB:	**30 PERIODS**
1.	Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
2.	Determination of heat transfer coefficient under natural convection from a vertical Cylinder.
3.	Determination of heat transfer coefficient under forced convection from inside tube
4.	Determination of Thermal conductivity of composite wall.
5.	Determination of Thermal conductivity of insulating powder
6.	Heat transfer from pin -fin apparatus (natural & forced convection modes)
7.	Determination of Stefan –Boltzmann constant
8.	Determination of emissivity of a gray surface
9.	Effectiveness of Parallel / counter flow heat exchanger
II REFRIGERATION AND AIR CONDITIONING LAB	**15 PERIODS**
1	Determination of COP of a refrigeration system
2	Performance test on Air conditioning system
3	Performance test on a HC Refrigeration System
	TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to		
CO1	Build the practical knowledge on working principles of refrigeration and air conditioning system.	3
CO2	Demonstrate the working principles of heat exchanger	3
CO3	Identify the practical familiarity on operation of conductive, convective and radiation heat transfer apparatus	3

REFERENCES:

1.	Mathur. R.B. and R.P. Sharma, "Internal Combustion Engines"., Dhanpat Rai & Sons 2007.
2.	Ramalingam. K.K., "Internal Combustion Engine Fundamentals", Scitech Publications, 2002.
3.	Ganesan, "Internal Combustion Engines", II Edition, TMH, 2002. 94
4.	R. C. Sachdeva, Fundamentals of Engineering Heat Transfer, New Age Science Ltd., New Delhi; Year: 2009
5	Thermal Engineering Laboratory Manual prepared by Faculty of Mechanical Engineering

COURSE ARTICULATION MATRIX:															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	1	2	3
1.	3	3													3
2.	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**	**QUANTITY**
1	Lagged pipe apparatus	1
2	Natural convection-vertical cylinder apparatus	1
3	Forced convection inside tube apparatus	1
4	Composite wall apparatus	1
5	Thermal conductivity of insulating powder apparatus	1
6	Pin-fin apparatus	1
7	Stefan-Boltzmann apparatus	1
8	Emissivity measurement apparatus	1
9	Parallel/counter flow heat exchanger apparatus	1
10	Refrigeration test rig	1
11	Air-conditioning test rig	1

VI SEMESTER

ME22601	DESIGN OF TRANSMISSION SYSTEMS	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES:

1.	To gain knowledge on the principles and procedure for the design of flexible elements.
2.	To familiarize the standard procedure available for Design of cylindrical gears.
3.	To insight the standard procedure available for Design of bevel and worm gear drives.
4.	To impart the knowledge on gears in the design of gear box.
5.	To give a design approach for clutches and brake systems.

UNIT I	DESIGN OF FLEXIBLE ELEMENTS	9

Design of Flat belts and pulleys - Selection of V belts and pulleys – Design of Transmission chains and Sprockets.

UNIT II	SPUR GEARS AND PARALLEL AXIS HELICAL GEARS	9

Gear materials – Gear Nomenclatures - Design of straight tooth spur and helical gears based on strength and wear considerations .

UNIT III	BEVEL AND WORM GEARS	9

Straight bevel gear: Tooth terminology, Estimating the dimensions of pair of straight bevel gears.
Worm Gear: merits and demerits - terminology, efficiency, estimating the size of the worm gear pair.

UNIT IV	GEAR BOXES	9

Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications.

UNIT V	CLUTCHES AND BRAKES	9

Design of plate clutches –axial clutches. Band and Block brakes - external shoe brakes – Internal expanding shoe brake.

TOTAL: 45 PERIODS

Guidelines (If any)

Use of approved PSG design data book is permitted in the examinations.

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Understand the principles and procedure for the design of flexible elements.	2
CO2	Apply the design practice for spur and helical gear drives using the manufacture's catalogue.	3
CO3	Analyze the bevel and worm gear drive design by adopting the manufacture's catalogue	4
CO4	Execute design methodology for gear box.	4
CO5	Implement the design procedures of clutches and brakes using the manufacture's	4

	catalogue.	
TEXTBOOKS:		
1.	Bhandari V, “Design of Machine Elements”, Tata McGraw-Hill Book Co, 5th Edition, 2020.	
2.	Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett “Mechanical Engineering Design”, Tata McGraw-Hill, 10th Edition, 2015	
REFERENCES:		
1.	Alfred Hall, Halowenko, A and Laughlin, H., “Machine Design”, Tata McGraw-Hill Book Co.(Schaum’s Outline), 2010.	
2.	Ansel Ugural, “Mechanical Design – An Integral Approach", Tata McGraw Hill Book Co, 2nd Edition, 2015.	
3.	Bernard Hamrock, Steven Schmid, Bo Jacobson, “Fundamentals of Machine Elements”, Tata McGraw-Hill Book Co., 3rd Edition, 2014.	
4.	Jindal, U.C., “Machine Design -Design of Transmission System”, Dorling Kindersley, 2010.	
5.	Merhyle F. Spotts, Terry E. Shoup and Hornberger, Lee. E, “Design of Machine Elements”, Printice Hall, 8th Edition, 2003.	
6.	Prabhu, T.J., “Design of Transmission Elements”, Mani Offset, Chennai, 2000.	
7.	Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine Design”, Wiley, 2013.	
E-Resources:		
1.	https://nptel.ac.in/courses/112106137/	
2.	https://nptel.ac.in/courses/112/105/112105124/	

COURSE ARTICULATION MATRIX

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

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

ME22602	METROLOGY AND QUALITY CONTROL: THEORY AND PRACTICES	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

1.	To provide a comprehensive understanding of inspection techniques and metrology principles essential in engineering and manufacturing contexts.
2.	To offer a comprehensive overview of advanced metrology techniques and instrumentation utilized in engineering and scientific fields.
3.	To deliver a comprehensive understanding of inspection methodologies, quality control, and quality assurance principles crucial for ensuring product quality in manufacturing processes.

UNIT I	Basics of metrology and instruments, metrology of gears, screw threads and surface finish	10

Introduction- need for inspection-accuracy and precision - errors in measurements – material and wavelength standards, limits, fits and tolerances – overview of vernier and micrometer instruments – Angle measurements - gear terminology – errors in spur gears – measurement of gear elements -Parkinson gear tester – screw thread terminology – measurement of pitch, major, minor and effective diameter – surface metrology concepts, terminology - specification of surface texture characteristics, analysis of surface traces – center line average value – Tomlinson surface meter, Taylor–Hobson talysurf.

UNIT II	Comparators, interferometers and applied mechanical measurements	10

Comparators - mechanical, pneumatic – applications – interferometers – Michelson interferometer, NPL flatness interferometer, laser interferometers – measurement of force – load cells –measurement of temperature – thermocouple – pyrometry concepts – total radiation pyrometer – optical pyrometer – acoustical measurement – characterization of sound – basic acoustical parameters – sound measuring apparatus – microphones – sound level meter – autocollimator – straightness measurement, coordinate measuring machines – basic configuration – probes - applications. Nanometrology – importance - scanning electron microscope – principles of XRD -Bragg's law – two dimensional XRD system – applications of XRD.

UNIT III	Inspection and quality control	10

Quality – inspection – quality control and quality assurance - chance and assignable causes of quality variation – statistical basis of the control chart- control limits, sample size and sampling frequency – rational subgroups – analysis of patterns on control charts – Introduction and Application: X bar and R chart, X bar and S chart – p chart – acceptance sampling – advantages and disadvantages – single sampling plan – OC curve – effect of N and C on the OC curves.

LABORATORY COMPONENT	30

LIST OF EXPERIMENTS

1.	Calibration of measuring instruments: Vernier caliper/ Micrometer/ Dial gauge/ Vernier height gauge/ Bevel protector.
2.	Measurement of lengths, heights, diameters by vernier calipers, micrometers etc.
3.	Measurement of bores by bore dial gauge / telescopic gauge
4.	Inspection of gear parameters by gear tooth vernier / Tool maker's microscope.
5.	Tolerance checking using pneumatic/mechanical comparator and plotting of appropriate control charts
6.	Measurement of Thread parameters using Floating Carriage Micrometer.

7.	Surface roughness measurement using roughness measuring instrument and plotting of appropriate control charts using MATLAB.
8.	Angle and taper measurements with bevel protractor, sine bars, rollers and balls.
9.	Linear and angular measurement/Inspection of given specimen using CMM and plotting of appropriate control charts using MATLAB.
10.	Force measurement using transducers.
11.	Temperature measurement using Thermocouples/Thermistor/RTD.
12.	Measurement of straightness/flatness using spirit level/ Autocollimator.
	TOTAL: 60 PERIODS

CO No.	**COURSE OUTCOMES**	**RBT Level**
At the end of the course, students will be able to:		
CO1	demonstrate proficiency in **analyzing** the given data and **find** limits, tolerances, and the type of fit for the given hole-shaft pair.	4
CO2	demonstrate the skill to **select**, **calibrate** and **use** precision measuring instruments for linear, angular measurements and to inspect gears, threads and surface quality parameters	3
CO3	demonstrate the capability to **choose** appropriate measuring instruments and **measure** force, temperature, and acoustic emission.	3
CO4	**measure** straightness, flatness and geometrical features of the given object using autocollimator and coordinate measuring machine.	3
CO5	**plot** control charts for variables and attributes to the given problems and **analyze** patterns on control charts to detect deviations from the norm.	4

TEXTBOOKS:

1.	N.V. Raghavendra, L. Krishnamurthy, “Engineering Metrology and Measurements” Oxford press, 2013
2.	Thomas G. Beckwith, John H. Lienhard V, Roy D. Marangoni, “Mechanical Measurements” Pearson, 2020.
3.	Douglas C. Montgomery, “Introduction to statistical quality control”, Wiley, 2020.

REFERENCES:

1.	Jain R.K “Engineering Metrology”, Khanna Publishers, 21st edition, 2005.
2.	Gupta. I.C., “Engineering Metrology”, 7th edition, Dhanpat Rai Publication, 2012.

E-RESOURCES:

1.	https://nptel.ac.in/courses/112/104/112104250/
2.	https://nptel.ac.in/courses/112/106/112106179/

COURSE ARTICULATION MATRIX:

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

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

SL.No.	ITEM DESCRIPTION	QUANTITY
1.	Micrometer	10
2.	Vernier Caliper	10
3.	Vernier Height Gauge	3
4.	Vernier Depth Gauge	3
5.	Bore gauge	1
6.	Telescope gauge	1
7.	Slip Gauge Set	6
8.	Gear Tooth Vernier	2
9.	Sine Bar	2
10.	Floating Carriage Micrometer	1
11.	Profile Projector / Tool Makers Microscope	Each 1
12.	Mechanical / Pneumatic Comparator	Each 1
13.	Autocollimator	1
14.	Temperature Measuring Setup	3
15.	Force Measuring Setup	1
16.	Coordinator Measuring Machine	1
17.	Surface finish measuring equipment	1
18.	MATLAB - Statistics and Machine learning toolbox	1 license

ME22611	MATLAB FOR MECHANICAL ENGINEERS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

1.	To add proficiency in MATLAB syntax, basic operations, and data types.
2.	To introduce simulation methodologies using Simulink for engineering applications.
3.	To impart knowledge, to apply MATLAB and Simulink for solving engineering problems in various domains.

LIST OF EXPERIMENTS

I	**INTRODUCTION TO MATLAB AND BASIC OPERATIONS**
1.	Introduction to MATLAB, basic syntax, Data types.
2.	Algebraic Operations.
3.	Matrix Operations.
4.	Plotting data.
5.	Solving Calculus and Differential equations in MATLAB.
6.	Solving problems on simple Engineering Mechanics applications
7.	Solving Problems on simple Mechanical vibrations applications.
II	**SIMULATION APPLICATION WITH SIMULINK AND SIMSCAPE**
1.	Simulation of basic Algebraic functions using Simulink.
2.	Electrical Circuit Analysis and Simulation using Simulink.
3.	Control System Simulation: Doorbell Implementation with Solenoid Valve.
4.	Mechanical System Dynamics Simulation: Vibration Response in a Bicycle.
5.	Thermal System Simulation: Heat Transfer Problem Analysis using Simulink.

TOTAL: 60 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Perform mathematical operations, plotting data, and solving calculus and differential equations using MATLAB.	3
CO2	Apply toolbox functions to analyze electrical circuits, mechanical system dynamics, and thermal system simulations.	4
CO3	Apply MATLAB and Simulink toolbox to solve problems related to engineering mechanics, mechanical vibrations, electrical circuits, control systems, and heat transfer, thereby enhancing problem-solving abilities in engineering contexts.	3

TEXTBOOKS:

1.	Holly Moore, "MATLAB for Engineers", 6th Edition, 2022
2.	Andrew P. King and Paul Aljabar, "MATLAB Programming for Biomedical Engineers and Scientists", 3rd Edition, 2023
3.	Harold Klee and Randal Allen, "Simulink Dynamic System Simulation for MATLAB", 5th Edition, 2021
4.	Bahram Shahian, Benjamin C. Kuo, and Gene Franklin, "Control System Design Using MATLAB

	and Simulink", 4th Edition, 2022
5.	Haym Benaroya and Mark Nagurka, "Mechanical Vibration: Analysis, Uncertainties, and Control", 3rd Edition, 2023

COURSE ARTICULATION MATRIX:

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

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	Description of Equipment	Qty
HARDWARE		
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
SOFTWARE		
4.	MATLAB Licensed software	30 licenses
5.	Licensed operating system	Adequate

HS22511	INTERVIEW AND CAREER SKILLS LABORATORY (Common to AD, AE, CS, EE, EC, IT, MR, ME, AND MN)	L	T	P	C
		0	0	3	2

COURSE OBJECTIVES:

1.	Build confidence and develop learners' language proficiency.
2.	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 - fundamentals of entrepreneurial skills - developing leadership qualities and team work;– 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 - Influencing in Business Meetings - Active Listening and responding - Role-play - Strengthening – Negotiating/ Argumentative and Persuasive Skills - Defend a character/idea or attack it. - Networking Skills - engaging strangers in a conversation - introducing themselves, making small talk.

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Develop approaches for mastering international English language tests such as IETLS and TOEFL, as well as national-level competitive exams.	
CO2	Make presentations and participate in Group Discussions.	

CO3	Face interviews with confidence and develop strategies for negotiating job offers.	
CO4	Build effective resumes, cover letters and professional emails to enhance job application success.	
CO5	Explore strategies for scaling and growing entrepreneurial ventures.	

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.
3.	International English Language Testing System Practice Tests, Cambridge University Press.
4.	Interactive Multimedia Programs on Managing Time and Stress.
5.	Personality Development (CD ROM), Times Multimedia, Mumbai.

WEB SOURCES:

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
5.	http://www.mindtools.com/pages/article/newCDV_34.html

COURSE ARTICULATION MATRIX:

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

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

3 means 'a strong correlation' as the students need to use all the skills like appropriate body language, formal grammatically correct spoken and written English and exhibit a holistic personality in academic and professional situations.

ME22612	COMPREHENSION II	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

1.	To provide a complete review of Mechanical Engineering topics covered in fifth and Sixth semesters so that a comprehensive understanding is achieved.
2.	To strengthen the students in fundamentals pertaining to core courses
3.	To make the students to face job interviews, competitive examinations and to enhance the employment potential

CONTENTS

1.	Fundamentals of Theory of Machines
2.	Fundamentals of Machine Design
3.	Basics of Computer Aided Modelling
4.	Basics of Heat and Mass Transfer
5.	Basics of Refrigeration and Air Conditioning
6.	Fundamentals of Metrology
7.	Fundamentals of Quality Control
8.	Fundamentals of Failure Analysis and Prevention.

TOTAL: 30 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Understand and strengthen the fundamentals in Professional core courses	3

Evaluation

After revising the fundamentals, a Multiple-Choice questions-based test will be conducted every week in each subject. The grade will be awarded based on the score secured by the students in each subject.

COURSE ARTICULATION MATRIX:

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1.	3												3	2	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 an 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 Engineer Designing for the safety-Intellectual Property rights (IPR)-Case Study - Bhopal Gas Tragedy, Tunnel 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.	Mike W.Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2017	
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**	**3**
1	2							3		1			1		
2	2	1					1	3		2					
3						3		3							
4		2					1	3		2			1		
5						2		3	2	2					

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

ME22708	ENERGY CONVERSION TECHNIQUES: THEORY AND PRACTICES	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

1.	To identify the methods and technologies for effective utilization of solar energy.
2.	To acquire knowledge about wind energy conversion techniques
3.	To understand the basic concept of hybrid and electric vehicle.
4.	To impart practical knowledge on thermal energy conversion techniques.
5.	To impart practical knowledge on energy conversion techniques.

UNIT I	SOLAR AND WIND ENERGY CONVERSION TECHNIQUES	12

Solar Radiation- Solar collectors - Flat Plate and Concentrating Collectors-Solar Applications – Solar Cells - Fundamentals of Solar Photo Voltaic Cells, Power Generation &Applications. Wind Energy – Wind data, Site selection, power available in wind. Wind energy conversion – Principle, evolution of windmills, Vertical and Horizontal axis windmills, Construction and working, Safety and failure.

UNIT II	THERMAL ENERGY CONVERSION TECHNIQUES	8

Steam Boiler-Types and comparison-Mountings and Accessories. Fuels - Solid, Liquid and Gas. Performance calculations. Steam Turbines-Types, -Impulse and reaction principles, Velocity diagrams, Work done and efficiency – optimal operating conditions. Multi-staging, compounding and governing.

UNIT III	ELECTRIC VEHICLE	10

Electric vehicle layout, performance of electric vehicles, vehicle performance, energy consumption, Concepts of hybrid electric drive train, types, architecture of series and parallel hybrid electric drive train, merits and demerits, Selection of motors and controllers.

LABORATORY COMPONENT	30

LIST OF EXPERIMENTS

1.	Study on Steam Generators and Turbines.
2.	Performance Test on a Steam Generator.
3.	Energy balance Test on a Steam Generator.
4.	To determine the quality of steam using Steam Calorimeter.
5.	Performance Test on Steam Turbine.
6.	Study the Properties of various Biodiesels and alcohols.
7.	Performance, Combustion and Emission test on Four stroke CI Engine fueled with Biodiesels.
8.	Performance Test on Solar Collector.
9.	Study on Hybrid Electric Vehicle.
10.	Study on Steam Condenser.

TOTAL: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	understand the working principles of solar energy conversion devices.	2

CO2	aware the concepts of wind energy conversion systems and its applications.	2
CO3	analyze the energy conversion in the simple steam power plant.	3
CO4	familiar about the functioning of electric vehicle systems.	3
CO5	gained the practical knowledge on energy conversion techniques.	3

TEXTBOOKS:

1.	Archie W. Culp, "PrinciplesofEnergyConversion",McGraw-HillInc.,Singapore,1991.
2.	Rajput. R.K., "Thermal Engineering", Laxmi Publications, Tenth Edition, 2017.
3.	Rai. G.D., "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 2011.
	Mehrdad Ehsani, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRC Press, 2005.

REFERENCES:

1.	Ibrahim Dincerand Mark A. Rosen, "Thermal Energy Storage Systems and Applications", John Wiley & Sons 2002.
2.	Kettari M.A., "Direct Energy Conversion", Addison-Wesley Pub. Co 1999
3.	Ganesan.V, "Internal Combustion Engines", Third Edition, Tata Mcgraw Hill, 2007.
4.	Kothandaraman. C.P., Domkundwar. S, Domkundwar. A.V., "A Course in Thermal Engineering", Fifth Edition, Dhanpat Rai & Sons, 2002.

E-RESOURCES:

1.	https://onlinecourses.nptel.ac.in/noc23_ch76/preview
2.	https://nptel.ac.in/courses/121106014

COURSE ARTICULATION MATRIX:

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

SL.No.	ITEM DESCRIPTION	QUANTITY
1.	Four stroke Diesel Engine with electrical loading	1
2.	Data Acquisition system with any one of the above engines	1
3.	Steam Boiler	1
4	Steam Calorimeter	1

5	Steam Turbine with Electrical Dynamometer	1
6	Steam Condenser	1
7	AVL Emission Analyzer	1
8	AVL Combustion Analyzer	1
9	Solar Collector	1
10	Pyranometer	1

ME22709	COMPUTER AIDED ENGINEERING: THEORY AND PRACTICES (Common to ME and MN)	L	T	P	C
		1	0	4	3

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, modal analysis. Two Dimensional problems: Plane stress, Plane strain and Axisymmetric problems in CST elements – Isoparametric elements – Gauss Integration.

UNIT III	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
12.	Vibration analysis of spring-mass systems.
13.	Modal analysis of Beam.

TOTAL: 75 PERIODS

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

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**	**3**
1	**3**	**3**											**2**		**2**
2	**3**	**3**	**3**		**3**								**2**		**2**
3	**3**	**3**	**3**		**3**								**2**		
4	**3**	**3**	**3**		**3**								**2**		

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

ME22710	DIGITAL MANUFACTURING: THEORY AND PRACTICES	L	T	P	C
		1	0	4	3

COURSE OBJECTIVES:

1.	To impart knowledge in writing and interpreting CNC programs using industry-standard programming languages like G-codes and M-codes, enabling them to effectively control CNC machines.
2.	To impart knowledge in principles and fundamental concepts of additive manufacturing processes and demonstrate the additive manufacturing processes.

UNIT I	CNC machines and part programming	5

Introduction – Advantages of CNC Machines – Machine structure – Guideways – Feed drives – Spindle bearings – Measuring systems, Controls, Software, and user interface Gauging - Introduction to part programming – Coordinate system – Dimensioning- Axes and motion nomenclature – Part program structure – G codes and M codes – linear and circular interpolation – subroutines – canned cycles – Programming examples for machining and turning center.

UNIT II	Introduction to AM, photopolymerization and powder bed fusion	5

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– Powder bed fusion – Selective laser sintering – Powder recycling

UNIT III	Other AM processes	5

Wire arc additive manufacturing – Post process – Friction stir additive manufacturing (FSAM) – Process parameters Hybrid AM – Material issues in AM - Direct Digital Manufacturing – Applications of Direct Digital Manufacturing - Software for AM

LABORATORY COMPONENT	60

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: 75 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Explain** constructional features, operate CNC machines, and able to be proficient in **writing** and **interpreting** CNC programs of G-codes and M-codes.	4
CO2	**Explain** the principles, fundamental concepts, challenges and **select** materials and additive manufacturing processes for the given application.	3
CO3	**Explain** the principles and **select** suitable materials for wire arc, friction stir, DDM and hybrid AM and **recommend** a process for the given application.	3
CO4	**Analyze** the given part diagram and **generate** CNC programs utilizing G-codes and M-codes and **execute** CNC programs in CNC machines.	4
CO5	**Design** and **develop** engineering components using different additive manufacturing techniques.	3

TEXTBOOKS:

1.	HMT, "Mechatronics" McGrawHill, 2018.
2.	Ian Gibson, David Rosen,brent stucker, Mahyar Khorasani, "Additive Manufacturing Technologies", Springer, 3rd edition, 2020.

REFERENCES:

1.	Serope Kalpakjian & Steven R. Schmid, "Manufacturing Engineering and Technology",Pearson India Education Services Pvt. Ltd, 8e in SI units, 2023.
2.	SK Sinha, "CNC programming (FANUC control)", Galgotta, 2022.
3.	Fanuc series oi-model F, Operator's Manual.

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**	**3**
1	3	3		3	3				2	1		1		3	
2	3				3				2	1		1		3	
3	3				3				2	1		1		3	
4	3	3		3	3				2	2		1		3	
5	3				3				3	3		3	1	3	

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS		
SL.No.	**ITEM DESCRIPTION**	**QUANTITY**
1.	SEENC turn software	5 licenses
2.	SEENC mill software	5 licenses
3.	CNC Turning Center	1 No
4.	Vertical Machining Center	1 No
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

ME22711	INDUSTRIAL ROBOTICS: THEORY AND PRACTICES	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

1.	To make the students understand the fundamental principles and theories of industrial robotics.
2.	To implement robot kinematics and dynamics control in robotics.
3.	To develop skills in programming and integrate industrial robots into manufacturing processes.

UNIT I	FUNDAMENTAL OF ROBOTICS	10

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 – End effectors and its types.

UNIT II	ROBOT KINEMATICS	10

Robot Kinematics - Forward and Inverse - Denavit - Hartenberg (DH) parameters - Homogeneous Transformations - Robot Dynamics - Configuration of a robot controller.

UNIT III	ROBOT CELL DESIGN AND APPLICATIONS	10

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.

LABORATORY COMPONENT **30 Periods**

LIST OF EXPERIMENTS

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

TOTAL: 60 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 and end effectors	3
CO2	Analyze and implement advanced control strategies for industrial robots.	3

CO3	Ensure the safety and proper maintenance of industrial robots in industrial settings.	3
CO4	Demonstrate proficiency in programming and simulating industrial robots.	3
CO5	Create and interpret different robot programs to perform the desired task	3

TEXTBOOKS:

1.	"Industrial Robotics: Technology, Programming, and Applications" by Mikell P. Groover

REFERENCES:

1.	"Robotics for Engineers" by Yoram Koren
2.	"Introduction to Autonomous Robots" by Nikolaus Correll et al.
3.	"Robotics: Control, Sensing, Vision, and Intelligence" by C.S.G. Lee and K. S. Fu
4.	Mitsubishi Electric Industrial Robot - CR800-D Controller RV-8CRL Standard Specifications manual
5.	Lab Manual prepared by department of Mechanical Engineering, SVCE

E-RESOURCES:

1.	https://nptel.ac.in/courses/112105319
2.	https://nptel.ac.in/courses/112104298
3.	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**	3
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)

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

SL No.	ITEM DESCRIPTION	QUANTITY
1.	6 axis robots with teach pendant	01
2.	Robot programming software license	10
3.	Conveyor system	01
4.	Air compressor	01
5.	Desktop computer	10
6.	UPS	As required

ME22811	**PROJECT WORK**	**L**	**T**	**P**	**C**
		0	**0**	**20**	**10**

COURSE OBJECTIVES:

Apply the knowledge gained from various courses within the program to address the identified problem, considering the following criteria

1.	Identification of a real time societal or Industrial problems
2.	Review of literatures and identification of gaps
3.	Formulating objectives and methodology of the project
4.	Design and develop an appropriate numerical model / prototype wherever applicable and perform optimization studies.
5.	Testing and validation of the model
6.	Analysis and interpretation of results
7.	Preparation of detailed report

- Students, working in groups of 3 to 4, collaborate with project supervisors to choose a topic aligned with societal or industrial needs, subject to approval by the Head of the department.
- Projects may encompass theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, or a blend of these approaches.
- Project progress is assessed through a minimum of three reviews, with the review committee appointed by the Head of the Department.
- Prior to the end-semester viva voce examination, students must submit a detailed project report to their supervisor and the Head of the Department for acknowledgment.
- Evaluation of project work occurs during the viva voce presentation and report submission, with both internal and external examiners appointed by the Head of the Department.

TOTAL: 300 hours

COURSE OUTCOMES

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

- Formulate specific problem statements for real-life problems with reasonable assumptions and constraints.
- Conduct literature searches in the relevant area of interest.
- Develop suitable solution methodologies for the identified problems.
- Conduct experiments, design and analysis, and iterate solutions, documenting the results.
- Perform error analysis, benchmarking, and costing assessments
- Synthesize the results to draw scientific conclusions, produce products, or propose solutions.
- Document the findings in technical reports or presentations.

VERTICALS
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, learners will be able to:		
CO1	Understand the Design philosophy and select of materials for design.	3
CO2	Analyze casting, welding and forming processes towards improving manufacturability.	4
CO3	Apply various machining parameters towards improving machinability.	3
CO4	Select suitable manual handling procedure and analyze assembly efficiency	4
CO5	Analyze Lifecycle assessment and remanufacturing with respect to environment.	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: (including NPTEL course)	
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**	**3**
1	3					1	1		1	1			1	1	
2	3	3				1	1		1	1			1	1	
3	3					1	1		1	1			1	1	
4	3	2				1	2		1	1			1	1	
5	3	3	3	1	1	1	2		1	1			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, learners 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**	**3**
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	2	

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, learners 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

TEXT BOOKS:

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**	**3**
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, learners 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

TEXT BOOKS:

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.	Product Design
4.	Karl Ulrich, Steven Eppinger, “Product Design and Development”, McGraw-Hill Education, 2012
5.	Burden, Rodger PDM: Product Data Management, Resource Publications, 2003
6.	Saaksvuori, Antti & Immonen, Anselmi. Product Lifecycle Management, Springer-Verlag, 2004
7.	Gerardus Blokdyk, “PLM Software A Complete Guide”, 2019
8.	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**	**3**
1	3	2	2		1							1	2	1	
2	3	2	2		1					1		1	2	1	
3	3	1	2		1					1		1	2	1	
4	3	1	2		1					1		1	2	2	
5	3	1	2		1					1		1	2	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	9

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

UNIT III	DESIGN FOR QUALITY PRINCIPLES	10

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	8

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, learners 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	3
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, learners 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**	**3**
1	3	2				2	2					1	2	1	
2	3	2				2	2					1	2	1	
3	3	1				2	2					1	2	1	
4	3	2				2	2					1	2	1	
5	3	2				2	2					1	2	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, learners will be able to:		
CO1	Possess a comprehensive understanding of value engineering and value analysis, distinguishing between the approaches and recognizing their significance in optimizing value within engineering projects.	3

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**	**3**
1	3	1	1		1		1					1	3		
2	3	1	1		1		1					1	3		
3	3	1	1		1		1					1	3		
4	3	1	1		1		1					1	3	2	
5	3	1	1		1		1				3	1	3	2	

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, learners 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.	4
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**	**3**
1.	3	3			3				3				3		
2.	3	3	3		3				3				3		
3.	3	3	3		3				3				3		
1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)															

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, learners 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	4

	domains.	
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: (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**	**3**
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, the 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**	**3**
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	7

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	10

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	10

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	10

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	8

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, learners 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**	**3**
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, learners 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

TEXT BOOKS:	
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: (including NPTEL course)	
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**	**3**
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	8

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	10

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	10

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	8

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: (including NPTEL course)	
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	3
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**	**3**
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	10

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	8

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

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.

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, learners 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**	**3**
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**	**9**

Evolution of ERP, Various Modules of ERP- Advantage of ERP- Integrated Information Systems- Business Modelling- ERP for SME- ERP for Make to Order Companies- Business Process Mapping - Design, Environment and its Selection for ERP Implementation.

UNIT II	**ERP AND RELATED TECHNOLOGIES**	**9**

Business Process Re-engineering, Management Information Systems (MIS), Decision Support Systems (DSS)- Executive Information Systems (EIS)- Advantages and disadvantages of EIS, Data Warehousing- Online Transaction Processing (OLTP)- Data Mining-Online Analytical Processing (OLAP)- Product Life Cycle Management (PLM)- Supply Chain Management(SCM)- ERP Security issues.

UNIT III	**ERP MODULE'S STRUCTURE**	**9**

Finance, Sales and Distribution, Manufacturing and Production Planning- Material and Capacity Planning- Shop Floor Control- Quality Management- JIT/Repetitive Manufacturing- Cost Management- Engineering Data Management

UNIT IV	**PURCHASING AND SALES PERSPECTIVE**	**9**

Role of ERP in Purchasing- Purchase Module- Features of purchase module- Benefits of purchase module- ERP Purchase System- Role of ERP in Sales and Distribution- Sub-Modules of the Sales and Distribution Module- Billing and sales support- Foreign trade- Integration of Sales and Distribution Module.

UNIT V	**FUTURE DIRECTIONS IN ERP**	**9**

New Trends in ERP- ERP to ERP II-Implementation of Organisation -Wide ERP, Development of New Markets and Channels- Latest ERP Implementation Methodologies- case studies- ERP and E-business.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners 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	3
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

Inspection- Definition & Role in quality, Classification and methods of inspection, Sampling for inspection- Acceptance sampling, Single, Double, Multiple and Random sampling, OC curve- AQL, AOQL, Producer's risk, Consumer's risk. Quality Assurance, Cost of poor quality, Prevention, External and internal failure cost. Quality Control- 7 QC Tools.

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, learners 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	3

	develop effective compensation plans and workplace layouts.	
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**	**3**
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, learners 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**	**3**
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

Risk and resiliency in logistics, Corporate Social Responsibility (CSR) for sustainability, Ethical framework and code of conduct, Block chain technology for supply chain transparency, Case studies of successful sustainability initiatives.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners 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**	**3**
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, learners 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.	James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2.	Janakiraman. B and Gopal. R. K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.
3.	Shridhara Bhat, "TQM Text and Cases", Himalaya Publishing House, 2002.
4.	Suganthi. L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
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**	**3**
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, learners 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	3

	allocation in warehouse operations.	
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**	**3**
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: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, learners 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**	**3**
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.	**ITEM DESCRIPTION**	**QUANTITY**
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, learners 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**	**3**
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, learners 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**	**3**
1	2					2	2								2
2	2					2	2								2
3	2					2	2								2
4	2					2	2								2
5	2					2	2								2

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, learners 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 Pres
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**	**3**
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, learners 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	3
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, learners 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**	**3**
1	3	2	2												2
2	3	2	2												3
3	3	2	2												3
4	3	2	2												2
5	3	2	2												2

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, learners 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**	**3**
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, learners 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	3

	production with respect to applications like-heating, cooling, desalination, power generation	
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**	**3**
1	2	2	2	2	2	2	1	2	3	2	3	3			2
2	2	2	2	2	3	2	3	2	2	2	3	3			2
3	2	2	2	2	2	3	3	2	3	3	2	3			2
4	3	2	3	3	3	3	3	2	3	2	3	2			2
5	3	3	3	3	3	3	3	3	3	2	3	3			2

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, learners 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**	**3**
1	3	3	2	1											3
2	3	3	2	1											3
3	3	3	2	1											3
4	3	3	2	1											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 MANUFACTURING	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 shopfloor.

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, learners 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

TEXT BOOKS:

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: (including NPTEL course)	
1.	https://www.researchgate.net/publication/340055758_Digital_Twin_Technology
2.	https://www.digitaltwinconsortium.org/webinars/
3.	Digital Twins from University of Michigan | Class Central 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**	**3**
1.	3											1		2	
2.	3		1	2	2							1		2	
3.	3		1	2	2	1						1		1	
4.	3						2	1				2		1	
5.	3		1				2					1		2	

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 Multirotor 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 - Multirotor 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, 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, learners 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
TEXT BOOKS:		
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, WileyPublication. 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 ",Maker Media, Inc, 2016 Manufacturing", 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: (including NPTEL course)		
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**	**3**
1.	3													2	
2.	3		2		2				2					1	
3.	3		1	1	2									1	
4.	3					2		2						1	
5.	3					2		2				1		2	
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 – EtherCAT - SERCOS II/III – CAN - CANopen - Modbus IDA - PROFINET- PROFIBUS - Ethernet/IP- Ethernet Powerlink - 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; https://onlinecourses.nptel.ac.in/noc22_cs19/preview
2.	https://ieeexplore.ieee.org
3	https://www.raspberrypi.org/documentation/ 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**	**3**
1.	3	2	2	3	2	2			2			3		2	
2.	3	3	2		2				2			2		1	
3.	3	2	1	1	2							2		2	
4.	3	3	2			2		2				2		2	
5.	3	2	1			2		2				1		1	
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**	**3**
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		3	

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 transform 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	3
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

COURSE ARTICULATION MATRIX:

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
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	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**	**3**
1.	3													1	
2.	1		3	2										3	
3.				2	1									1	
4.			2	2		1								2	
5.	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. A maximum of 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 a 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: 60 PERIODS

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: INDUSTRIAL AUTOMATION

MN22701	AI AND ML FOR AUTOMATION (Common to MN and ME)	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 propose strategies to address ethical concerns and ensure responsible use of AI technologies	4

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

ME22072	APPLIED ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	Understanding the principles and applications of robotics in various fields.
2.	Developing skills in designing and implementing robotic systems for real-world tasks.
3.	Analyzing and evaluating advanced techniques in robot perception and manipulation.

UNIT I	INTRODUCTION TO APPLIED ROBOTICS	9

Overview of robotics principles, components, and applications - classification, sensors, actuators, and programming paradigms -Challenges and opportunities in applying robotics to different domains.

UNIT II	ROBOT PERCEPTION AND SENSING	9

Methods for robot perception and sensing including computer visionand depth sensing -Feature extraction, object recognition, and environment modeling for robotic navigation and manipulation.

UNIT III	ROBOT MANIPULATION AND CONTROL	9

Inverse kinematics, motion planning, grasping, and manipulation algorithms -Designing and implementing control strategies for robotic arms and end-effectors.

UNIT IV	MOBILE ROBOTICS AND NAVIGATION	9

Mobile robotics platforms and navigation algorithms for autonomous operation - localization, mapping, path planning, and obstacle avoidance -Practical application of mobile robotics in real-world scenarios.

UNIT V	ADVANCED TOPICS IN APPLIED ROBOTICS	9

Emerging trends in applied robotics - swarm robotics, human-robot interaction, collaborative robotics, and ethical considerations in robotics - Future of robotics.

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 components of robotics and their applications in various fields.	2
CO2	Design and implement robotic systems for specific tasks, considering hardware and software requirements.	3
CO3	Analyze and evaluate techniques for robot perception, manipulation, and navigation.	2
CO4	Develop solutions to real-world problems using advanced robotics concepts and methodologies.	3
CO5	Communicate effectively and collaborate in teams to solve complex robotics challenges.	3

TEXTBOOKS:

1.	"Robotics: Modelling, Planning and Control" by Bruno Siciliano and Lorenzo Sciavicco
2.	"Industrial Robotics: Technology, Programming, and Applications" by Mikell P. Groover

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**	**3**
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)														

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**	**3**
1.	3	2	1									1		2	
2.	3	2	1									1			
3.	3	2	1									1			
4.	3	3	3	2	3							2		1	
	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	3
1.	3	2	1									1		1	
2.	3	2	1									1			
3.	3	2	1									1		1	
4.	3	3	3	2	3							2			
5.	3	3	3	3		2	2	2	2	2		2		1	

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

ME22075	MICROCONTROLLER AND EMBEDDED SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To study the Architecture, assembly language programming and Interfacing of 8085 microprocessors.
2.	To develop programming skills of 8051 microcontroller with interfacing and to explore applications of 8051 microcontroller.
3.	To be familiar with the embedded and overview of real-time Operating systems and the processes involved.

UNIT I MICROPROCESSOR AND ITS PERIPHERAL INTERFACING 9

8085: Functional block diagram –- Signals – Memory interfacing – I/O ports and data transfer concepts – Timing Diagram – Interrupts - Study of Architecture and programming of ICs: 8255 PPI, 8259 PIC, 8251 USART, 8279 Key board display controller and 8254 Timer/ Counter.

UNIT II MICROCONTROLLER 9

8051 – Architecture, Special Function Registers (SFRs), Instruction set, Addressing modes, Assembly language programming, I/O Ports, Timers/counters, Interrupts, and serial communication.

UNIT III MICROCONTROLLER SYSTEM DESIGN 9

Keyboard and display interface –Temperature monitoring and control – Traffic light control – Frequency Measurement – Waveform Generation – Closed loop control of servo motor- stepper motor control –Washing Machine Control.

UNIT IV INTRODUCTION TO EMBEDDED SYSTEM 9

Introduction to embedded computing: Characteristics of embedded computing applications, Challenges in embedded system design, Embedded system Design process. Introduction to OS- GPOS versus RTOS- Classification of RTOS- Example Real-time operating systems– POSIX/Windows CE. Evaluating operating system performance.

UNIT V APPLICATIONS OF EMBEDDED SYSTEMS 9

GPS Navigation System – Engine control unit – Pacemaker– Defibrillator – Smart Vending Machine –Smart Home Security System – Challenges and trends in embedded systems in industrial applications.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Acquire knowledge of the architecture and instruction sets of the 8085 microprocessors.	2
CO2	Develop programs in 8051 microcontrollers by understanding its architecture and instruction set.	3
CO3	Design various interfacing units with 8051 microcontroller-based systems	4
CO4	Acquire knowledge about embedded systems and the concept of RTOS.	2
CO5	Design real-time consumer/industrial applications using embedded-system concepts.	4

TEXTBOOKS:

1.	Ramesh S. Gaonkar, 'Microprocessor Architecture Programming and Applications with 8085', Penram Intl. Publishing, 6th Edition, 2013.
2.	Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay 'The 8051 Microcontroller and Embedded Systems using Assembly and C', Prentice Hall Publications, 2nd Edition, 2008.

3.	Rajkamal, 'Embedded System-Architecture, Programming, Design', Mc Graw Hill, 2013.

REFERENCES:

1.	Krishna Kant, 'Microprocessors and Microcontrollers, Architecture, Programming and System Design - 8085, 8086, 8051, 8096', Prentice Hall India Ltd Publications, 1st Edition, 2010
2.	Sencer Yeralan, Helen Emery, 'Programming and Interfacing the 8051 Microcontroller', Addison-Wesley Publications, 1st Edition, 2000.
3.	Kenneth J. Ayala., "The 8051 Microcontroller, 3rd Edition, Thompson Delmar Learning, 2012.
4.	Jonathan W.Valvano, "Embedded Microcomputer Systems Real Time Interfacing", Third Edition Cengage Learning, 2012.
5.	Sriram V Iyer, Pankaj Gupta, "Embedded Real-Time Systems Programming", Tata McGraw-Hill, 2017.
6.	K.V.K.K.Prasad, "Embedded Real-Time Systems: Concepts, Design & Programming", DreamTech Press, 2005.

E-RESOURCES:

1.	https://onlinecourses.nptel.ac.in/noc20_ee98/preview
2.	https://onlinecourses.nptel.ac.in/noc20_ee42/preview

COURSE ARTICULATION MATRIX:

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

MN22601	MODERN MATERIAL HANDLING SYSTEMS (Common to MN and ME)	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**	**3**
1	2									3				1	
2	2				2	2				3		3		1	
3	2				2	2				3		3		1	
4	2				2	2				3		3			
5	2				2	2		1		3		3		1	
	1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)														

ME22077	SENSORS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To understand the working principles of various sensors and instrumentation used in Automation engineering.
2.	To learn about signal conditioning, data acquisition systems, and the interfacing of sensors.
3.	To apply various sensors and instrumentation knowledge in real-world mechanical engineering problems.
4.	To gain the expertise in designing and implementing sensor-based systems.

UNIT I	INTRODUCTION TO SENSORS AND INSTRUMENTATION	9

Overview of sensors and instrumentation - Classification of sensors: Active vs. Passive, Analog vs. Digital - Static and Dynamic Characteristics of sensors - Classification of errors – Error analysis –Sensor calibration techniques – Sensor Output Signal Types.Introduction to common sensors: Temperature, Pressure, Flow, Level, Direction, Range and Force sensors.

UNIT II	SIGNAL CONDITIONING AND DATA ACQUISITION	9

Basics of signal conditioning: Filtering – Amplification – Linearization -Analog to Digital and Digital to Analog conversion - Sample and Hold circuits.Data acquisition systems (DAS): Components – Data Loggers – configurations – applications. Role of LabVIEW in data acquisition and signal processing - Interfacing sensors with control systems – PID Controllers.

UNIT III	MOTION, PROXIMITY AND RANGING SENSORS	9

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT IV	FORCE, MAGNETIC AND HEADING SENSORS	9

Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor - Heading Sensors – Compass, Gyroscope, Inclinometers – Real time implementation.

UNIT V	OPTICAL, PRESSURE AND TEMPERATURE SENSORS	9

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

TOTAL : 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Identify and describe the working principles of various sensors and instrumentation.	2
CO2	Design and implement sensor-based systems for measurement and control.	3
CO3	Analyze and interpret data from sensors for use in mechanical engineering applications.	4
CO4	Integrate sensors with control systems to automate mechanical processes.	4
CO5	Evaluate the performance of instrumentation systems in terms of accuracy, precision,	5

	and reliability.	

TEXTBOOKS:

1.	Ernest O. Doebelin, "Measurement Systems: Application and Design," McGraw-Hill Education, 2009.
2.	D. Patranabis, "Sensors and Transducers," PHI Learning Private Limited, 2014.

REFERENCES:

1.	John G. Webster, "The Measurement, Instrumentation, and Sensors Handbook," CRC Press, 1999.
2.	P. P. L. Regtien, "Sensors for Mechatronics," Elsevier, 2012.
3.	DVS Murthy, Transducers and Instrumentation, PHI 2nd Edition2013

E-RESOURCES:

1.	IEEE Xplore Digital Library for the latest research on sensor technologies.
2.	NPTEL (National Programme on Technology Enhanced Learning) for online courses and lectures on sensors and instrumentation.
3.	Coursera and edX for courses on IoT and smart sensors.
4.	Arduino and Raspberry Pi official documentation for DIY projects involving sensors.

COURSE ARTICULATION MATRIX:

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

ME22070	MINI PROJECT (Common to ME and MN)	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 a 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: 60 PERIODS

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 8: DIVERSIFIED COURSES GROUP I

ME 22081	AUTOMOBILE ENGINEERING (Common to ME and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1.	To teach 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 educate various transmission systems of automobile.
4.	To understand 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, learners 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	3

	working system.	
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**	**3**
1	2	2	2												2
2	2	2	2												2
3	2	2	2												2
4	2	2	2												2
5	2	2	2												2

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, learners 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

TEXT BOOKS:	
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**	**3**
1	3	2		2			1			1			3	1	
2	3	2		2			1			1			3	1	
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, learners 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

TEXT BOOKS:	
1.	Arora, C.P., "Refrigeration and Air Conditioning", 3rd edition, McGraw Hill, NewDelhi, 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**	**3**
1	2	2	2	1											2
2	2	2	2	1											2
3	2	2	2	1											2
4	2	2	2	1											2
5	2	2	2	1											2

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, learners 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
TEXT BOOKS:		
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**	**3**
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, learners 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	4

	conditions.	
CO5	Evaluate the performance of intelligent control systems in terms of stability, robustness, and adaptability, comparing them to conventional control methods.	4
TEXT BOOKS:		
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: (including NPTEL course)		
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	3
1	3	3										1	2	1	
2	3	2										1	1	1	
3	3	2										1	2	2	
4	3	2			2							1	1	1	
5	3	2			2							1	2	1	
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. Pollutioncontrol 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, learners 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 andtheir 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	3

	interpret economics of power generation and pollution control methods	
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 UniversityPress, 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**	**3**
1	2	2	2												2
2	2	2	2												2
3	2	2	2												2
4	2	2	2												2
5	2	2	2	1											2

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**	**3**
1	1	2	2	2		2	1		2	1	1	1			
2	1	1	2	1		1	1		1	2	2	1			
3	1		1	1	3		2	3	3		2	1			
4	1		1	1	1	2	3	1			3	1			
5	1	3	3	2	3	2				3	1	1			

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

ME 22088	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, learners 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	3
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)

VERTICALS 9: Diversified Courses Group II

MN22709	DATA SCIENCE FOR INDUSTRIAL AUTOMATION: THEORY AND PRACTICES (Common to MN and ME)	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 Minitab
2. Perform the Correlation and covariance test using Minitab
3. Perform the Chi square goodness of fit using Minitab
4. Conduct the ANOVA and develop a linear model using Minitab
5. Create Histogram, Scatterplot and box plot using Minitab
6. Forecast the data with the linear models using Minitab
7. Forecast the data with the nonlinear regression model using Minitab
8. Decision tree
9. Support Vector Machines (SVM)
10. Cluster analysis

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 withdraw useful conclusions from acquired data set	3
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: (including NPTEL course)	
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**	**3**
1	3	2	2									2	2		
2	3	2	1									2	2		
3	3	2	1									2	2		
4	3	2	3		3							3	3		
5	3	2	3		3							3	2		

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

AE22602	HYBRID AND ELECTRIC VEHICLES (Common to AE, ME, and MN)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To make the students 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, and 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. election 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.	Ottorino Veneri, "Technologies and Applications for Smart Charging of Electric and Plug-in Hybrid Vehicles", 1st edition, Springer Publishing, 2017	
2.	Ron HodKinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication, 2005.	
3.	Ronald K. Jurgen, "Electric and Hybrid-Electric Vehicles: Engines and Powertrains", SAE International, 2015.	
4.	Tom Denton, "Electric and Hybrid Vehicles", 1st edition, Routledge Publishers, 2017.	
5.	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://archive.nptel.ac.in/courses/108/103/108103009/	
2.	https://onlinecourses-archive.nptel.ac.in/noc19_ee18/preview	

ME22091	GAS DYNAMICS AND JET PROPULSION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To instill the basic difference between compressible and incompressible flow in variable area cross section and constant area duct.
2.	To impart the phenomenon of shock waves and its effect on flow.
3.	To impart basic Knowledge about jet propulsion and Rocket Propulsion

UNIT I	**BASIC CONCEPTS AND ISENTROPIC FLOWS**	9

Energy and momentum equations of compressible fluid flows – Stagnation states, Mach waves and Mach cone – Effect of Mach number on compressibility – Isentropic flow through variable ducts – Nozzle and Diffusers, Design of inlets nozzles and Diffusers

UNIT II	**FLOW THROUGH CONSTANT AREA DUCTS**	9

Flows through constant area ducts with heat transfer (Rayleigh flow), Slope of Rayleigh line, and Friction (Fanno flow) Slope of fanno line -variation of flow properties.

UNIT III	**NORMAL AND OBLIQUE SHOCKS**	9

Governing equations –Variation of flow parameters across the normal and oblique shocks –Prandtl –Meyer relations, Rankine-Hugoniot equations, Strength of the shock–Applications.

UNIT IV	**JET PROPULSION**	9

Theory of jet propulsion –Thrust equation –Thrust power and propulsive efficiency, thermal efficiency – Operating principle, cycle analysis, performance characteristics of ram jet, turbojet, turbofan and turbo prop engines, Aircraft matching.

UNIT V	**SPACE PROPULSION**	9

Types and working of rocket engines – Propellants - feeding systems – Theory of rocket propulsion – Performance study – Terminal and characteristic velocity – Applications – space flights.-Rocket equations

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to		
CO1	Interpret the one-dimensional compressible flow through variable area duct.	3
CO2	Apply governing equations to compressible flow through constant area duct with friction and heat transfer.	3
CO3	Identify the suitable solution for the compressible flow in normal and oblique shock.	3
CO4	Analyze the propulsion methods, concepts of aircraft propulsion system and performance of the jet.	3
CO5	Apply the concepts of gas dynamics in space propulsion system	3

TEXTBOOKS:

1.	Anderson, J.D., "Modern Compressible flow" 3rd Edition, McGraw Hill, 2003.
2.	Yahya, S.M. "Fundamentals of Compressible Flow", New Age International (P) Limited, New Delhi, 6th edition, 2016.

REFERENCES:

1.	Hill. P. and C. Peterson, "Mechanics and Thermodynamics of Propulsion" , Addison – Wesley Publishing company, 1992.
2.	Zucrow. N.J., "Aircraft and Missile Propulsion", Vol.1 & II, John Wiley, 1975.
3.	Zucrow. N.J., "Principles of Jet Propulsion and Gas Turbines", John Wiley, New York, 1970.
4	Sutton. G.P., "Rocket Propulsion Elements", John wiley,New York,1986,.
5	Shapiro. A.H.,"Dynamics and Thermodynamics of Compressible fluid Flow", John wiley, New York, 1953.
6	Ganesan. V., "Gas Turbines", Tata McGraw Hill Publishing Co., New Delhi,1999.
7	Somasundaram. PR.S.L., "Gas Dynamics and Jet Propulsions", New Age International Publishers, 1996.
8	Babu. V., "Fundamentals of Gas Dynamics", ANE Books India, 2008.
9	Cohen. H., G.E.C. Rogers and Saravanamutto, "Gas Turbine Theory", Longman Group Ltd.,1980.

E-RESOURCES:

1.	https://www.youtube.com/watch?v=_6796gj7-Gw
2.	https://www.youtube.com/playlist?list=PLbMVogVj5nJR0Vt9CLGK7ck2yrS1zQjMo

COURSE ARTICULATION MATRIX:

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

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

ME22092	INDUSTRIAL PIPING ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1.	To gain the knowledge on basics of piping, component, Quality control and maintenance.
2.	To understand the piping pressure estimation equations, buckling pressure.
3.	To insight the standard guideline to follow the supports and layout.
4.	To impart the knowledge fatigue and flexibility analysis.
5.	To understand the importance and measurement of vibration and leak test of piping.

UNIT I	INTRODUCTION	9

Fundamentals- Materials-Design- System Design-Component Design –Construction- Quality Control Inspections -Preoperational Testing - Mechanical Testing - Operational Testing - Maintenance – Operation.

UNIT II	PIPING PRESSURE	9

Pressure Design of Piping - Thin Wall Approximation - Pipeline Design Equation - Yield and Wall Thickness - Pressure Design of Plant Piping -Lame's Formula - Early Design Equation - Piping Design Equations - Allowable Stress - Wall Thickness Allowance - Yield and Burst Pressure - The Von Mises Yield Pressure - Burst Pressure - Design Pressure - Design Scenarios - Pressure Excursions - Over-Pressure Protection - Burst Energy - Pipe Specification - External pressure - Buckling Pressure.

UNIT III	LAYOUT AND SUPPORTS	9

Spacing of Pipe Supports - Sustained Stress - Stress Indices - Design Standards - Selection of Pipe Supports - Variable Spring - Constant Load Hanger - Rigid Frames - Road Hangers - Pipe Rolls - Rigid Struts - Vibration Dampers - Snubbers - Anchors - Saddles - Design of Standard Support - Layout Rules of Good Practice - Equipment Elevations - Equipment Spacing - Piping.

UNIT IV	FLEXIBILITY AND FATIGUE	9

Layout for Flexibility - Simplified Flexibility Analysis - Fatigue - Smooth Specimen Fatigue - Pipe Component Fatigue - Fatigue Strength of Butt Welds - Fracture Mechanics Approach - Corrosion Fatigue -- Wall Temperatures - Creep Damage - Pipe Insulation - Expansion Joints.

UNIT V	VIBRATION, LEAK AND PRESSURE TEST	9

Mechanically Induced Vibration - Hydraulic Induced Vibration - Vane and Piston Motion - Turbulence Induced Vibration - Measuring Vibration - Measuring Displacement - Measuring Velocity - Measuring Acceleration - Leak Test and Pressure Test - Leak and Pressure Test Methods - Choice of Test Method - Conduct of Test - Plan the Test - Conduct the Test - Plan for Leaks - Drain and Dry - Isolation - Locating Leaks Underground.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Evaluate and select appropriate materials for piping construction based on their mechanical properties, corrosion resistance, and compatibility with process fluids.	3
CO2	Calculate the Von Mises, yield pressure, burst pressure and buckling pressure for piping components to ensure structural integrity under different loading conditions.	3
CO3	Analyze piping layouts and determine appropriate spacing for pipe supports based on design standards, pipe material, and operating conditions.	3

CO4	Evaluate the effects of wall temperatures on piping flexibility and fatigue behavior, considering insulation and temperature control measures.	3
CO5	Plan and conduct vibration and leakage tests effectively, considering safety, accuracy, and reliability.	3

TEXTBOOKS:	
1.	George A.Antaki, "Piping and Pipeline Engineering" Marcel Dekker, Inc,2003.
2.	James Pennock , "Piping Engineering Leadership for Process Plant Projects", "Gulf Professional Publishing", 1st Edition, 2001.
REFERENCES:	
1.	Kirshna Murty ,"Industrial Piping Practice and Maintenance", Industrial Press, Inc.2010.
2.	Kenneth Storm , "Industrial Piping and Equipment Estimating Manual", 1st Edition, Gulf Professional Publishing, 2017.
3.	Peter Smith, "Advanced Piping Design",1st Edition, Gulf Publishing Company,2013.
E-Resources:	
1.	https://onlinecourses.nptel.ac.in/noc21_ch52/
2.	https://archive.nptel.ac.in/courses/103/105/103105210/

COURSE ARTICULATION MATRIX:

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

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

ME22093	MECHATRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To enhance student proficiency in the strategic selection of sensors for crafting mechatronic systems.
2.	To comprehend the architecture and timing diagram of a microprocessor, and to interpret its functionalities effectively.
3.	To design suitable interfacing circuits for connecting input/output (I/O) devices with a microprocessor effectively.
4.	To incorporate Programmable Logic Controllers (PLCs) as controllers in mechatronic systems.
5.	To conceptualize, design, and develop an appropriate mechatronic system tailored to a specific application.

UNIT I	INTRODUCTION AND SENSORS	9

Introduction to Mechatronics – Systems – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and Dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance Sensors – Strain Gauges – Eddy Current Sensor – Hall Effect Sensor – Temperature Sensors – Light Sensors.

UNIT II	8085 MICROPROCESSOR	9

Introduction – Pin Configuration - Architecture of 8085 – Addressing Modes – Instruction set, Timing diagram of 8085.

UNIT III	PROGRAMMABLE PERIPHERAL INTERFACE	9

Introduction – Architecture of 8255, Keyboard Interfacing, LED display – Interfacing, ADC and DAC Interface, Temperature Control – Stepper Motor Control – Traffic Control Interface.

UNIT IV	PROGRAMMABLE LOGIC CONTROLLER	9

Introduction – Architecture – Input / Output Processing – Programming with Timers, Counters and Internal relays – Data Handling – Selection of PLC.

UNIT V	ACTUATORS AND MECHATRONICS SYSTEM DESIGN	9

Types of Stepper and Servo motors – Construction – Working Principle – Characteristics, Stages of Mechatronics Design Process – Comparison of Traditional and Mechatronics Design Concepts with Examples – Case studies of Mechatronics Systems – Pick and Place Robot – Engine Management system – Automatic Car Park Barrier.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	**Select** appropriate sensors based on system requirements and specifications.	3
CO2	**Describe** the architecture of a microprocessor including its components and their functions	2
CO3	**Design** interfacing circuits to ensure compatibility between the microprocessor and connected I/O devices.	4
CO4	**Design** the PLC program logic using ladder logic or other programming languages to control the operation of the mechatronics system.	4
CO5	**Develop** the architecture and software logic required to achieve the desired functionality	4

	and behavior of the mechatronics system.	
TEXT BOOKS:		
1.	Bolton W., "Mechatronics", Pearson Education, 6th Edition, 2015.	
2.	Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Penram International Publishing Private Limited, 6th Edition, 2013.	
REFERENCES:		
1.	Bradley D.A., Dawson D., Buru N.C. and Loader A.J., "Mechatronics", Chapman and Hall, 2013.	
2.	Davis G. Alciatore and Michael B. Histand, "Introduction to Mechatronics and Measurement systems", McGraw Hill Education, 2018.	
	Devadas Shetty and Richard A. Kolk, "Mechatronics Systems Design", Cengage Learning, 2016.	
2.	Nitaigour Premchand Mahalik, "Mechatronics Principles, Concepts and Applications", McGraw Hill Education, 2015.	
3.	Smaili. A and Mrad. F, "Mechatronics Integrated Technologies for Intelligent Machines", Oxford University Press, 2017.	
E-RESOURCES: (including NPTEL course)		
1.	https://archive.nptel.ac.in/courses/112/107/112107298/	
2.	https://www.edx.org/learn/engineering/the-georgia-institute-of-technology-the-mechatronics-revolution-fundamentals-and-core-concepts	

COURSE ARTICULATION MATRIX:

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

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

MN22403	OPERATIONS RESEARCH AND MANAGEMENT (Common to ME and 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 - Northwest 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, learners 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

TEXT BOOKS:

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	3
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)

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 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 Biomaterials – 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 Electroactive 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 Piezoelectric -Energy Harvesting - Vibration and Noise-Control Applications

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level

At the end of the course, learners 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

TEXT BOOKS:

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**	**3**
1	3	2				1			1	1		2		3	
2	3	2				1			1	1		2		3	
3	3					1			1	1		2		3	
4	3					1			1	1		2		3	
5	3					1			1	1		2		3	

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

ME22094	TRIBOLOGY IN DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1.	To impart knowledge in lubrication and friction.
2.	To provide knowledge in wear, and corrosion aspects of machine components, and its preventions.
3.	To impart knowledge on surface engineering and surface modification methods that will come in handy to solve the industrial problems. This will also serve as a precursor for future research in the same field.

UNIT I	ENGINEERING SURFACES & FRICTION	9

Elements of Tribology - Tribology in industry - Surfaces and Friction Topography of Engineering surfaces - Contact between surfaces - Various tribological problems and solutions - Sources of sliding Friction - Adhesion, ploughing Friction, theories of friction, Friction control, Surface texture and measurement, stick-slip motion

UNIT II	LUBRICANTS AND LUBRICATION REGIMES	9

Lubricants and their physical properties – Viscosity and other properties of oils – Additives and selection of Lubricants – Lubricant standards ISO, SAE, AGMA, BIS standards – Lubrication Regimes – Solid Lubrication – Hydrodynamic lubrication – Hydrostatic lubrication – Gas lubrication - Oil seals and gasket.

UNIT III	WEAR AND ITS MECHANISMS	9

Wear, theories of wear, Types of wear - Simple theory of sliding wear mechanism –Adhesive wear - Abrasive wear - Corrosive wear - Surface fatigue wear – wear under extreme conditions. Wear of ceramics and polymers - Wear measurements, wear prevention.

UNIT IV	CORROSION & PREVENTION	9

Introduction - Principle of corrosion - Classification of corrosion - Types of corrosion - Factors influencing corrosion - Testing of corrosion - Evaluation of corrosion - Prevention of Corrosion - Material selection for corrosive environment.

UNIT V	SURFACE COATING AND TREATMENT	9

Introduction – Surface properties, Superficial layer – Changing surface metallurgy – Wear resistant coatings and Surface treatments – Techniques – PVD – CVD – Physical CVD – Ion implantation – Thermal spraying – Laser surface hardening and alloying, Applications of coatings and surface treatments in wear and friction control –New trends in coating technology –DLC – CNC – Thick coatings – Nano-engineered coatings – Corrosion resistant coatings.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Apply the concept of surface friction, comprehend the topography of engineering surfaces and apply various solutions to tribological problems.	3
CO2	Select suitable lubricants and lubrication regimes for different operating conditions	3
CO3	Apply the knowledge of theories and mechanisms of various types of wear in real time applications.	3
CO4	Apply the principles of corrosion and select the preventive measures.	3
CO5	Analyze the material / surface properties based on the functions of tribological requirements and surface modification methods/treatments.	3

TEXTBOOKS:	
1.	Stachowiak G W & Batchelor A W, "Engineering Tribology", Third Edition, Elsevier Inc., 2005.
2.	Basu. S.K, Sengupta. S.N and Ahuja. B.B, "Fundamentals of Tribology" Prentice – Hall of India Pvt Ltd, New Delhi, 2005.
3.	Fontana G., "Corrosion Engineering", McGraw Hill, 1985.
4.	Ludema K C, "Friction, Wear, Lubrication: A textbook in Tribology", CRC Press, 2010.
5.	Rabinowicz.E, "Friction and Wear of materials", John Willey &Sons, UK,1995
REFERENCES:	
1.	Avraham Harnoy, "Bearing Design in Machinery: Engineering Tribology and Lubrication", Dekker 2007.
2.	Giovanni Straffelini, "Friction and Wear: Methodologies for Design and Control", Springer 2015.
3.	Michael Khonsari.M, "Applied Tribology: Bearing Design and Lubrication", WileyBlackwell; 2nd Revised edition, 2008.
4.	Stolarsk.T.A, "Tribology in Machine Design, Butterworth", – Heinemann, UK, 2013.
E-Resources:	
1.	https://archive.nptel.ac.in/courses/112/102/112102015/
2.	https://archive.nptel.ac.in/courses/112/102/112102014/

COURSE ARTICULATION MATRIX

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

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

OPEN ELECTIVES

OE22001	GREEN MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To Provide students with a thorough understanding of green manufacturing principles and their significance in modern industry
2.	To Offer students with a comprehensive understanding of the twelve principles of green chemistry and the definition, importance, and influencing factors of green technology
3.	To Provide students with a detailed understanding of waste generation and management in manufacturing
4.	To Equip students with a thorough understanding of production systems, emphasizing the economic and ecological advantages of closed-loop systems
5.	To Introduce students to various forms of green energy, including solar, wind, biomass, and hydroelectric power, and their applications in manufacturing

UNIT I	INTRODUCTION TO GREEN MANUFACTURING AND SUSTAINABLE MATERIALS	9

Overview of green manufacturing principles-Importance and benefits of green manufacturing-Case studies of successful green manufacturing initiatives- Types of sustainable materials-Selection criteria for sustainable materials-Applications of sustainable materials in manufacturing processes.

UNIT II	GREEN CHEMISTRY AND TECHNOLOGY	9

Twelve principles of green chemistry- green technology-definition- importance- factors affecting green technology- Role of industry, government and institutions- industrial ecology- role of industrial ecology in green technology.

UNIT III	WASTE REDUCTION AND LEAN MANUFACTURING	9

Waste generation – Reasons-waste management in manufacturing – case study. Lean Manufacturing principles – Applications –advantages- disadvantages

UNIT IV	CLOSED-LOOP PRODUCTION SYSTEMS	9

Introduction to Production Systems- Economic and Ecological Benefits of Closed Loop Systems-Energy Consumption- Machine Tools -Process Parameter Optimization - Dry Machining and Minimum Quantity Lubrication - Remanufacturing.

UNIT V	GREEN ENERGY IN MANUFACTURING	9

Introduction to green Energy- Solar- Wind- Biomass - hydroelectric-applications in manufacturing-reducing the carbon footprint - environmental impact - climate change-sustainability goals - Environmental Policy—Present Atmosphere and Challenges for Green Manufacturing.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Explain the Green manufacturing principles and select suitable sustainable materials for green manufacturing.	3
CO2	Describe the principle of green chemistry and apply the green technology for	3

	industry.	
CO3	Analyze reduction of waste materials in manufacturing and apply lean manufacturing concept.	4
CO4	Measure energy consumption in machining process and optimize the machining parameters.	4
CO5	Select suitable energy source for green manufacturing.	3
TEXTBOOKS:		
1.	D. Dornfeld (ed.) Green Manufacturing: Fundamentals and Applications, Springer, New York, 2013.	
2.	Rashmi Sanghi and M.M. Srivastava, Green Chemistry, Environment Friendly Alternatives, Narosa Publishing House, New Delhi 2009.	
3.	Rao M.N. and Dutta A.K. Wastewater treatment, Oxford & IBH publishing Co. Pvt. Ltd., New Delhi, Second Edition, 2006	
REFERENCES:		
1.	Gradel.T.E. and B.R. Allenby, Industrial Ecology, Prentice Hall, 2010.	
2.	Frances Cairncross- Costing the Earth: The Challenge for Governments, the Opportunities for Business, Harvard Business School Press, 1993.	
3.	World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.	
4.	Rao CS Environmental Pollution Control Engineering, Wiley Eastern Ltd., New Delhi, 2006.	
5.	Lewis H Bell and Douglas H Bell, Industrial noise control, Fundamentals and applications, Marcel Decker, 1994.	
E-RESOURCES: (including NPTEL course)		
1.	https://archive.nptel.ac.in/courses/112/104/112104225/	

OE22002	LEAN SIX SIGMA	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	A comprehensive understanding of the core principles of Lean, including identifying and eliminating waste, creating value for customers, and optimizing processes for efficiency and effectiveness.
2.	Thorough understanding of the core principles, concepts, and methodologies of Six Sigma, including the DMAIC (Define, Measure, Analyze, Improve, Control) framework
3.	Learn and apply the use of statistical tools and techniques.

UNIT I	INTRODUCTION TO LEAN MANUFACTURING	9

Conventional Manufacturing versus Lean manufacturing - Principles of Lean Manufacturing - Basic elements of lean manufacturing - Introduction to Lean manufacturing tools

UNIT II	SET UP TIME REDUCTION, TQM, 5S, VSM	9

Set up time reduction -definition, philosophies and reduction approaches. TQM - Principle and implementation. 5S - Principle and implementation - Value Stream Mapping - Procedure and principle

UNIT III	INTRODUCTION TO SIX-SIGMA	9

Six Sigma measures - Yield - DPMO - Quality Level - Reliability function using Six-Sigma - MTTF using Six Sigma - Maintenance free operating period - Availability using Six Sigma - Examples

UNIT IV	ELEMENTS OF SIX SIGMA	9

Qualtiy Measurement techniques - SQC, Six Sigma Cp and Cpk - Statistical quality control (SQC) methods. Control charts and Six Sigma - Process capability index - Examples

UNIT V	TOOLS AND TECHNIQUES	9

SIPCO, QFD, Voice of the customer, Kano models, Cost of Poor Quality (COPQ) and DMAIC - Define, Measure, Analyze, Improve and Control - Case Studies for Six Sigma

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Have a comprehensive understanding of the core principles of Lean versus conventional manufacturing	2
CO2	Implement a set-up time reduction initiative to minimize changeover times between production runs, thereby increasing operational efficiency and reducing downtime.	3
CO3	Utilize Six Sigma methodologies to improve process efficiency by reducing defects	3

	per million opportunities (DPMO), thereby enhancing product quality and customer satisfaction.	
CO4	Implement quality measurement techniques such as Statistical Quality Control (SQC) methods, Six Sigma Cp and Cpk analysis, and control charts to assess process capability and drive continuous improvement initiatives for enhanced product quality and performance.	3
CO5	Apply Six Sigma methodologies to real-world case studies to achieve organizational excellence and customer satisfaction.	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/110105123

OE22003	3D PRINTING AND DESIGN: THEORY AND PRACTICES	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

1.	To gain foundational knowledge about additive manufacturing (AM) principles and technologies.
2.	To explore and understand the various AM processes available, including their capabilities and limitations.
3.	To develop proficiency in different post-processing methods used in AM to enhance the properties and aesthetics of printed parts.
4.	To investigate and analyze the diverse applications of AM across various fields and industries.

UNIT I	INTRODUCTION TO ADDITIVE MANUFACTURING	10

Introduction to AM, Technology overview & evolution, AM vs. CNC machining, Benefits of AM, Process chain (design, prep, build, post-processing), AM Processes (liquid, particle, molten, sheet).

UNIT II	DESIGN FOR AM	10

DFMA & AM capabilities, Design freedom exploration, Design tools & considerations: Part orientation, support removal, internal features, Interlocking parts, part count reduction, markings, Process selection: methods, challenges, examples, Production planning & control.

UNIT III	POST PROCESSING	10

Support Removal, Surface Texture Improvement, Dimensional Accuracy Improvement, Aesthetic Enhancement, Preparation for Patternmaking, Property Enhancement, AM application in various fields.

LABORATORY COMPONENT

LIST OF EXPERIMENTS

1.	**Orientation Impact:** Print the same simple object with different orientations (flat, on its side, angled) and compare the support structure needs, print time, and surface finish.
2.	**Interlocking Parts:** Design and print two interlocking parts that snap together securely without needing glue or screws. Test different interlocking mechanisms for strength and ease of assembly.
3.	**Textured Surface:** Print an object with a textured surface pattern (e.g., stippling, honeycomb) and compare its grip, aesthetics, and printability to a smooth surface.
4.	**Strength vs. Infill:** Print a simple object with varying infill densities (percentage of solid material inside) and test its breaking strength under load.
5.	**Filament Mixing:** (For compatible filaments) Experiment with manually mixing different filament colors to create unique marbled or blended effects.
6.	**Functional Prototype:** Design and print a simple, functional tool or device (e.g., phone stand, cable organizer) to test the practicality of 3D printed solutions.
7.	**Watertight Container Challenge:** Design and print a container with varying wall thicknesses and infill densities to test its ability to hold water.
8.	Prepare a 3D printed part for use as a pattern in a casting process. Adapt the part surface and consider necessary post-processing steps (e.g., sealing) for successful mold creation.
9.	Experiment with methods to improve the dimensional accuracy of a printed part.
10.	**Develop a basic production plan:**For a simple 3D printed object. Consider factors like print time, post-processing needs, material cost, and potential production volume.

TOTAL: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	**Understand** the principles of Additive Manufacturing (AM), file conversion, and STL file structure.	3
CO2	**Identify** various AM processes and their respective process parameters. Calculate build time for AM processes.	3
CO3	**Demonstrate** an understanding of design requirements specific to Additive Manufacturing	3
CO4	**Select** suitable post-processing methods in AM to achieve desired properties.	3
CO5	**Explain** the applications of AM in various fields**.**	3
TEXTBOOKS:		
1.	Chua Chee Kai, Leong KahFai, "Rapid Prototyping: Principles & Applications", World Scientific, 2003.	
2.	Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010	
REFERENCES:		
1.	Ali K. Kamrani, EmandAbouel Nasr, "Rapid Prototyping: Theory & Practice", Springer, 2006.	
2.	D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001.	
E-RESOURCES:		
1.	https://nptel.ac.in/courses/112104265/	
2.	https://learn-xpro.mit.edu/additivemanufacturing?utm_medium=sem&utm_source=google&utm_campaign=amx&utm_ter m=3d%20printing%20course&utmcontent=aw-c	

OE22004	ROBOTICS AND PROGRAMMING: THEORY AND PRACTICES	L	T	P	C
		2	0	2	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	10

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	10

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	10

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.

LABORATORY COMPONENT

LIST OF EXPERIMENTS

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

TOTAL: 60 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.	3
CO2	Analyze and implement advanced control strategies for industrial robots.	4
CO3	Describe the types of End effector for various applications	3

CO4	Operate the robot using teach pendant	3
CO5	Program the robot on different paths	3
TEXTBOOKS:		
1.	"Industrial Robotics: Technology, Programming, and Applications" by Mikell P. Groover	
2.	Lab Manual prepared by department of Mechanical Engineering, SVCE	
REFERENCES:		
1.	"Robotics for Engineers" by YoramKoren	
2.	"Introduction to Autonomous Robots" by NikolausCorrell et al.	
E-RESOURCES:		
1.	https://nptel.ac.in/courses/112105319	
2.	https://www.mitsubishielectric.com/fa/	

VALUE ADDED COURSES

VD22001	ADVANCED GEAR MANUFACTURING CONCEPTS	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

1.	Know about the gear terminology and types of gears
2.	Teach how to select a type of gear based on the applications
3.	Know the different methods of manufacturing gears
4.	Learn the gear materials and gear hardening methods

UNIT I	GEAR TERMINOLOGY AND TYPES OF GEARS	3

Review on gear tooth nomenclature, law of gearing, interference and undercutting, contact ratio. Gear tooth action, Gear tooth profiles –cycloidal and involutes profile, involutes profile generation. Addendum modification factor, backlash. Types of gears and applications

UNIT II	CYLINDRICAL GEARS MANUFACTURING	12

Cylindrical Gears – Introduction, types of cylindrical gears and applications, blank size calculation, overview of gear production methods, procedure for manufacturing gears in hobbing and gear shaping using disc cutter, cutter selection, work holding methods and setting calculations.
Rack type gear shaping machine-description and applications; Internal gear cutting methods.
Demonstration of cutting helical gears in gear hobbing and gear shaping machine

UNIT III	CONICAL GEARS MANUFACTURING	11

Types of conical gears and applications; Production methods for straight bevel gears: Bevel gear generator, Duplex rotary cutter method; Production methods for spiral bevel and hypoid bevel gears: Gleason spiral bevel generator.
Demonstration of cutting straight bevel gears using Universal Milling Machine.

UNIT IV	GEAR MATERIALS AND HARDENING METHODS	4

Properties of gear materials; Non-metallic, non-ferrous and plastic gears; Selection of material for power transmission and high-speed applications.
Hardening methods: Through hardening, case hardening; Carburizing-liquid and gas carburizing, low pressure carburizing; High pressure quenching, nitriding, induction hardening, flame hardening.

TOTAL: 30 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, the students will be able to:		
CO1	Select an appropriate gear manufacturing process, cutter, and machining parameters to manufacture various types of cylindrical gears	3
CO2	Select an appropriate gear manufacturing process, cutter and machining parameters to manufacture various types of conical gears	3
CO3	Suggest suitable materials and heat treatment methods for gears based on application	3

TEXTBOOKS:

1.	Gitin M. Maitra, “Hand book of gear design” 2nd edition, 2008
2.	Watson, "Modern Gear Production", 1st Edition, Pergamon Press, US, 1984.

REFERENCES:

1.	SAE, "Gear Design Manufacturing Inspection Manual", SAE, 1990
2.	HMT, "Production Technology", 1st Edition, Tata McGraw Hill, 2001

3.	Kapil Gupta, Neelesh Kumar Jain and Rudolph Laubscher, "Advanced gear Manufacturing and Finishing", Academic Press, 2017
E-RESOURCES:	
1.	https://www.youtube.com/watch?v=ZhDO16FDmxA
2.	https://www.youtube.com/watch?v=B8w-0Oi0Yf4
3.	https://archive.nptel.ac.in/noc/courses/noc17/SEM2/noc17-mm15/

VD22002	CONDITION MONITORING OF MACHINE TOOLS	L	T	P	C
		2	0	0	0

OBJECTIVES:

1.	Familiarize with the concept of condition-based maintenance to enhance the effective utilization of machines.
2.	Impart knowledge of artificial intelligence for machinery fault diagnosis.

UNIT I	BASIC CONCEPTS	10

Machinery failures and basic maintenance strategies, Factors influencing maintenance strategies, Machine condition monitoring, Different types of Condition Monitoring, transducer selection, and virtual instrumentation. Vibration signatures of faults in rotating machines and their detection and diagnosis.

UNIT II	INSTRUMENTATION AND SIGNAL PROCESSING	10

Instrumentation and Signal Processing: Types of sensors in condition monitoring: vibration, acoustics and noise, acoustic emission, temperature, ultrasonic and infra-red sensors – Signal processing: basic signal and systems concepts, time domain analysis, frequency domain analysis, time-frequency analysis, wavelets, and wavelet packets.

UNIT III	FAULT DIAGNOSTICS	10

Introduction to Faults in Rotating Machines, Unbalance Detection, Field Balancing, Misalignment, Crack and Looseness. Journal and Anti-Friction Bearings, Gears, Pumps and Cavitation, IC Engines, Machinery Diagnostic Chart

TOTAL: 30 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
1.	Select appropriate maintenance strategies and condition monitoring techniques for identifying failures in a machine.	**3**
2.	Acquire and process sound and vibration signals in a dynamic mechanical system.	**4**
3.	Predict faulty components in a machine by analyzing acquired vibration signals.	**4**

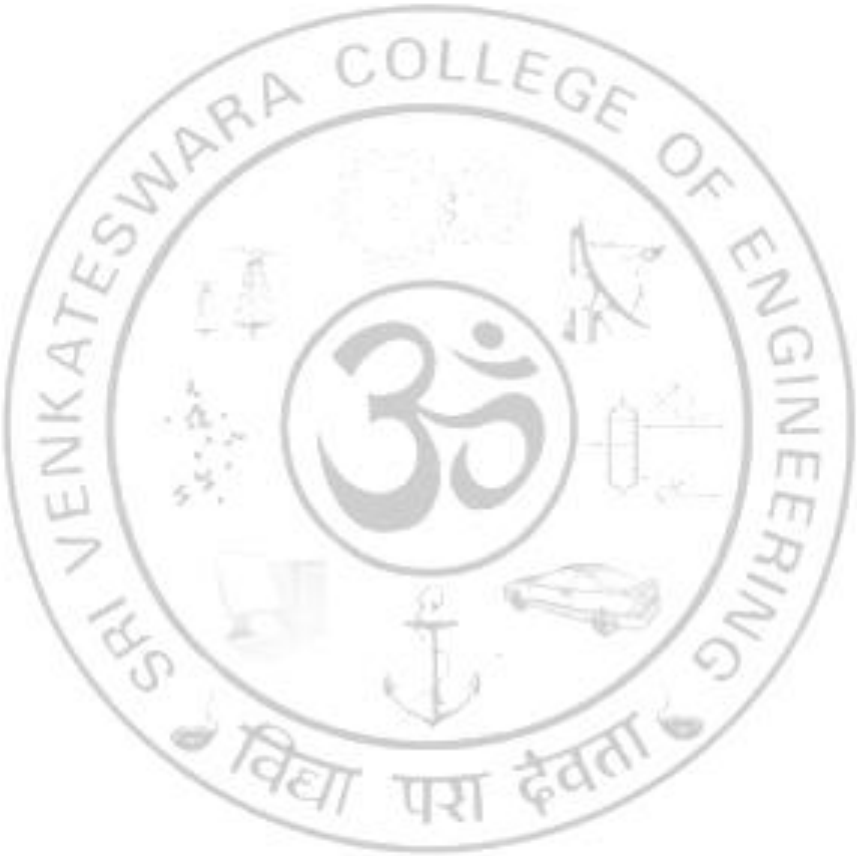
TEXTBOOKS:

1.	Clarence W. de Silva, "Vibration Monitoring, Testing and Instrumentation (Mechanical and Aerospace Engineering Series)," CRC Press, Taylor & Francis, 2007.
2.	A. R. Mohanty, "Machinery Condition Monitoring: Principles and Practices," CRC Press, Taylor & Francis, 2015.

REFERENCES:

1.	Collacot, "Mechanical Fault Diagnosis and Condition Monitoring," Chapman-Hall, 1987.
2.	Davies, "Handbook of Condition Monitoring – Techniques and Methodology," Springer, 1998.

3.	Cornelius Scheffer and Paresh Girdhar, "Practical Machinery Vibration Analysis and Predictive Maintenance," Elsevier, 2004
4.	Rao, Singiresu S. Mechanical Vibrations. 5th ed., Pearson, 2010.
E-RESOURCES:	
1.	https://archive.nptel.ac.in/courses/112/105/112105232/



VD22003	DESIGN AND DEVELOPMENT OF PRESS TOOLS	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

1.	Understand the various press working terminologies and dies
2.	Design a cutting die sets for a shearing operation
3.	Design a die sets for forming operations

UNIT I	PRESS WORKING TERMINOLOGY	6

Press operations – cutting and forming operations. Elastic recovery or spring back in sheet metal operations. Press tool components – Rating of a press, Press working terminology, working of a cutting die. Types of dies – Simple die, Compound die, Combination dies, Progressive dies, Transfer dies. Principle of Metal cutting, Press Tonnage calculations, Methods of reducing the cutting force, Minimum diameter of piercing, Shut height of a press and shut height of a die. Simple problems on strip layout, recommending minimum tonnage press, Center of pressure

UNIT II	DESIGN OF DIE SETS FOR SHEARING OPERATIONS	12

Types of blanking die – Drop-through die, Inverted type die. Strip layout. 14 steps involved in design of a die- How to Lay Out a Scrap Strip, How to Design Die Blocks, How to Design Blanking Punches, How to Design Piercing Punches, How to Design Punch Plates, How to Design Pilots, How to Design Gages, How to Design Finger Stops, How to Design Automatic Stops, How to Design Strippers, How to Apply Fasteners, How to Select a Die Set, Dimensions and Notes, The Bill of Material.

Design of Die sets for manufacturing a washer, blanks for forming operations, links of a Cyle chains.

UNIT III	DESIGN OF DIE SETS FOR FORMING OPERATIONS	12

Theory of Bending, Spring back and measures to control it, Calculations for Blank development of Simple Bent components, Minimum bend radius, Types of Bending dies

Theory of Drawing, Metal flow in Drawing & forming operations; reduction ratio and redrawing limits, draw clearance, drawing and blank holding forces for cylindrical draws only. Blank development of Cup

Design and development of bending, forming, drawing, reverse redrawing and combination dies – Blank development for axisymmetric, rectangular and elliptic parts – Single and double action dies.

TOTAL: 30 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, the students will be able to:		
CO1	**Design** an economical scrap strip layout and will **select** a suitable tonnage press for a given sheet metal component	3
CO2	**Design** and **develop** a sheet metal cutting die sets	3
CO3	**Design** and **develop** a forming die sets	3

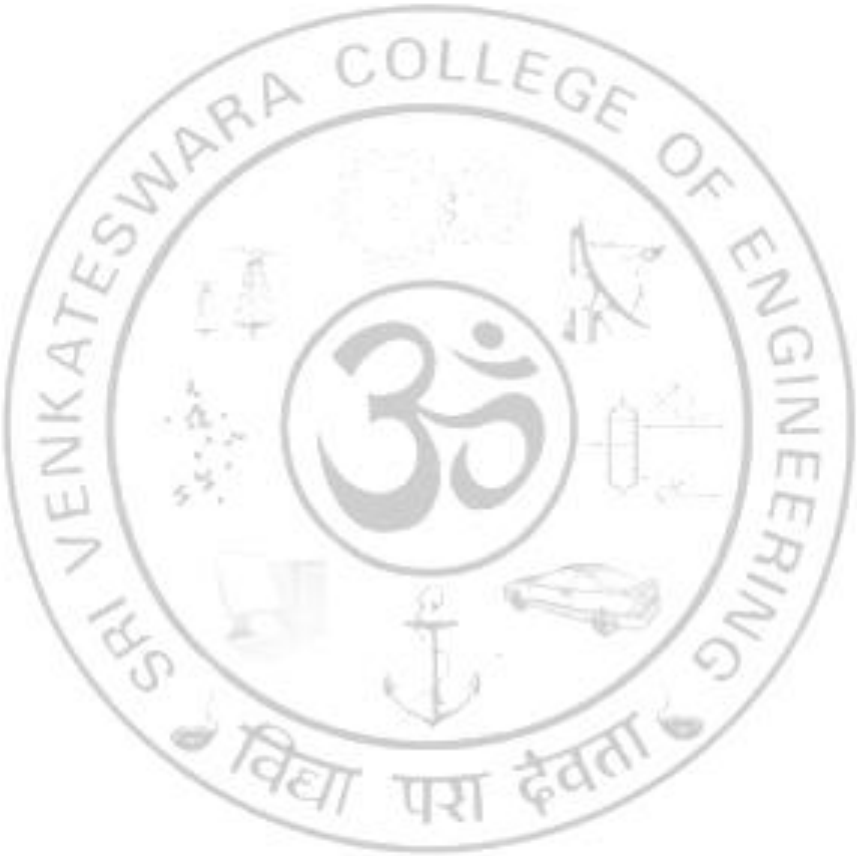
TEXTBOOKS:

1.	Joshi P.H "Press tools - Design and Construction", wheels publishing, 2020
2.	Donaldson.C, and LeCain.C.H, "Tool Design", Tata McGraw Hill Publishing Company Limited, New Delhi, 2012.

REFERENCES:

1.	Paquin. J.R., Die design Fundamentals, Industrial Press, 2006
2.	ASTM, Fundamentals of Tool Design Prentice Hall of India. 1962
3.	Donaldson.C, and LeCain.C.H, "Tool Design", Tata McGraw Hill Publishing Company Limited, New Delhi, 2012.

E-RESOURCES:	
1.	https://uni.edu/~rao/Mfg%20Tooling%20-10%20Prog%20Tools-2.pdf 2.
2.	https://www.academia.edu/6009091/DIE_DESIGN_FUNDAMENTALS
3.	https://www.youtube.com/watch?v=7lPtbTZLDUc
4.	https://www.youtube.com/watch?v=0z7dYQHhQUI
5.	https://www.youtube.com/watch?v=KFdoAYvU4SI
6.	http://ignou.ac.in/upload/bme059unit-3.pdf 3.



VD22004	ENGINE INSTRUMENTATION AND TESTING	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

1.	To provide in-depth knowledge of engine testing and evaluation techniques.
2.	To understand the combustion, emission from an IC engine and use of flow visualization techniques

UNIT I	ENGINE DYNAMOMETER AND TESTS EQUIPMENT	9

Design of Engine test cell, Engine dynamometers, data acquisition, fuel consumption meter, air fuel ratio measurement, oil consumption measurement, temperature and pressure measurement, humidity measurement

UNIT II	ADVANCED ENGINE TESTING	9

Use of special equipment, fuel injection pressure, Gas analyzer, combustion pressure, heat balance, gas exchange process, Gas chromatography, Spray and combustion photography,

UNIT III	ADVANCED MEASUREMENTS	12

Interferometer, Laser Doppler Anemometer, Hot wire Anemometer, Particle Image Velocimetry. Flame Ionization Detector, Non-Dispersive Infrared Analyzer,

TOTAL: 30 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to		
CO1	Understand the process of engine testing and emission measurements.	2
CO2	Get an exposure on the applicability of data acquisition system used in IC engines.	2
CO3	Apply advanced techniques for engine measurement and flow visualization techniques in IC engines.	2

REFERENCES:

1	Ganesan. V, Internal Combustion Engines, Tata McGraw Hill Book Co, 2013.
2.	Holman. J.P, Experimental Methods for Engineers, McGraw – Hill Inc., 2001.
3.	Wolfgang Merzkirch, Flow Visualisation, 2nd Edition, Academic Press, 1987
4	William.H. Crouse, Automotive Engines, McGraw Hill Publishers, 1985.
5	Ellinger, H.E, Automotive Engines, Prentice Hall Publishers, 1992.
6	Obert.E.F., Internal Combustion Engine analysis and Practice, International Text BookCo.,Scranton, Pennsylvania,1988.

VD22005	GEOMETRICAL DIMENSIONING AND TOLERANCE	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

1.	Provide students with a foundational understanding of Geometric Dimensioning and Tolerancing (GD&T) principles and their practical application in engineering design and manufacturing.
2.	Familiarize students with the components commonly found in geometrically dimensioned and tolerance drawings, with a focus on fits and allowance
3.	Instruct students in datum identification, focusing on the establishment of datum reference frames and the selection of appropriate datums for part alignment in engineering design and manufacturing
4.	Educate students on tolerances of form and orientation, with a focus on straightness, flatness, circularity, cylindricity, perpendicularity, angularity, and parallelism.
5.	Provide students with a comprehensive understanding of profile tolerancing, including profile of a surface and profile of a line

UNIT I	**6**
Introduction - Dimensioning Symbols - Geometric Characteristics –Principle- Practical application of GD&T principles in engineering design and manufacturing.	

UNIT II	**6**
Components common to geometrically dimensioned & tolerance drawing- fits & allowances, Practical examples, and applications of orientation on tolerances	

UNIT III	**6**
Datum Identification - Establishing datum reference frames and selecting appropriate datums for part alignment	

UNIT IV	**6**
Tolerances of Form-Straightness – Flatness - Circularity- Cylindricity - Tolerances of Orientation – Perpendicularity – Angularity – Parallelism	

UNIT V	**6**
Profile of a surface and line -Part Calculations - Circular and Total Runout - Runout Calculations.	

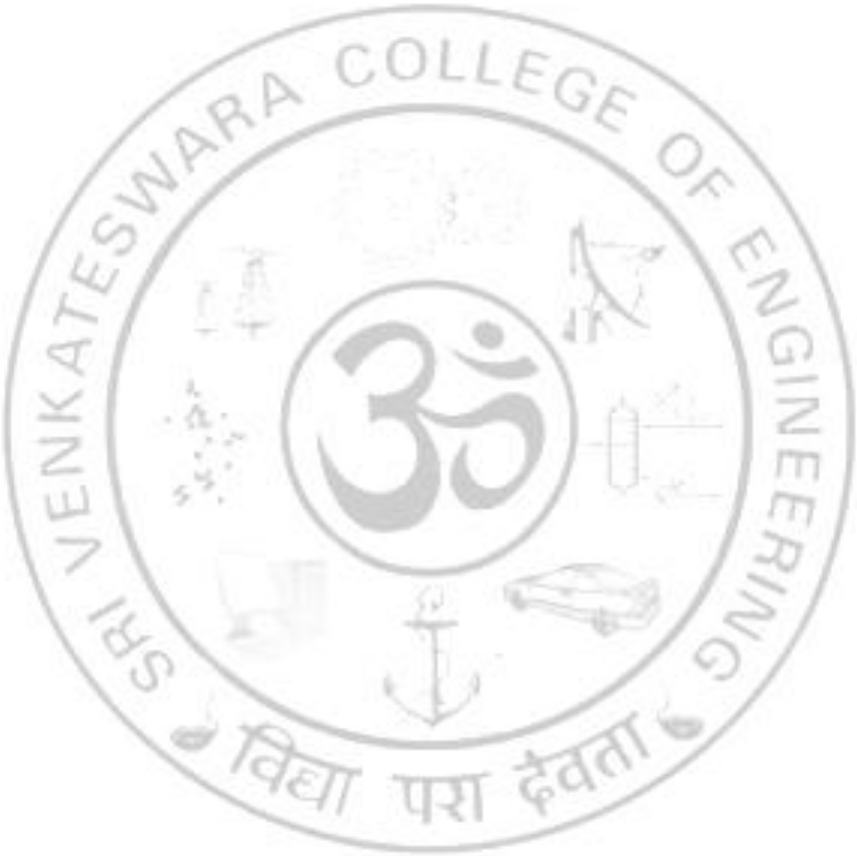
TOTAL: 30 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	**Explain** the GD & T principles and **select** suitable symbols and dimensioning for engineering components.	2
CO2	**Explain** the advantages of GD & T and **identify** suitable tolerance, fit and allowance for engineering components.	2
CO3	**Apply** suitable datum features and **determine** appropriate datum for part alignment	3
CO4	**Determine** flatness, circularity, cylindricity, perpendicularity, angularity, and parallelism	4
CO5	**Perform** design calculations associated with circular parts.	3

TEXTBOOKS:

1.	P.S. Gill “Geometric Dimensioning and Tolerancing”, S.K. Kataria and Sons; 2013.

2.	Alex Krulikowski, “Fundamentals of Geometric Dimensioning and Tolerancing”, Delmar Publishers, Second Edition, 2012.
3.	James D Meadows, “Geometric Dimensioning and Tolerancing”, Marcel Dekker, Inc
REFERENCES:	
1.	Daniel E. Puncochar, “Interpretation of Geometric Dimensioning and Tolerancing”, Industrial Press, New York, Third Edition, 2010.
E-RESOURCES: (including NPTEL course)	
1.	https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/112106179/lec1-14



VD22006	KAIZEN AND ITS APPLICATIONS	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

1. To familiarize the concepts of Kaizen and its significance in organizational improvement
2. To instill the core principles of Kaizen and their practical applications in organizational settings

UNIT I	INTRODUCTION	5

What is kaizen; why kaizen; History of Kaizen, Definition of Kaizen, philosophy, Types of kaizen; Objective of Kaizen ; Overview of lean production system What is Kaizen , Kaizen Blitz, Kaizen Culture

UNIT II	KAIZEN PRINCIPLES AND IMPLEMENTATION	7

Know your customer, let it flow, go to GEMBA, empower people, Be transparent.Five steps of identify the business case, Set goals, Select the team, Collect baseline data, Plan to support the Kaizen activity: study about basic founding element; steps to implement kaizen, Schedule for Kaizen

UNIT III	KAIZEN PROCESS	7

Ten step process-Define the Opportunity, Form the Team , Measure Current State ,Identify actions, Verify Action Effectiveness, Implement Permanent Actions, Validate Actions, Create Standard Work, Replicate the Improvement , Do It Again

UNIT IV	TOOLS USED IN KAIZEN	7

Kaizen Boards, Pareto Analysis, Affinity Diagram, Ishikawa or Fishbone Diagram, Is / Is Not, Comparative Analysis,5 S, FMEA/Risk Assessment, Standard Work.

UNIT V	VSM & CASE STUDIES	4

Case study on VSM using Kaizen, Study of Toyota Production system

TOTAL: 30 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Understand the principles and philosophy of Kaizen	2
CO2	Apply Kaizen principles and methodologies to improve business processes	3
CO3	Utilize Kaizen tools and techniques to drive continuous improvement initiatives within organizations	3

TEXTBOOKS:

1. George, M. L., Rowlands, D., Price, M., & Maxey, J, 'The Lean Six Sigma Pocket Toolbook' New York: McGraw-Hill,2005
2. Munro, R. A., Maio, M. J., Nawaz, M. B., Ramu, G., &Zrymiak, D. J, 'The Certified Six Sigma Green Belt Handbook', Milwaukee: ASQ Quality Press, 2008

REFERENCES:

1. Masakki Imai, "Gemba Kaizen:A Commonsense Approach to a Continuous Improvement Strategy", (2nh Edition), McGraw-Hill Publication

E-RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc23_mg06/preview

VD22007	KINEMATIC ANALYSIS OF MECHANICAL LINKS	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

1.	To develop a thorough understanding of the various mechanisms and its design with an ability to effectively use the various mechanisms in real life problems.

UNIT I	ADVANCED KINEMATICS OF PLANE MOTION	10

Introduction to plane motion. The Inflection circle, Euler – Savary Equation, Bobillier's Construction, Collineation axis, Hartmann's Construction, Inflection circle for the relative motion of two moving planes, Application of the Inflection circle to kinematic analysis, Polode curvature in the four-bar mechanism, coupler motion.

UNIT II	INTRODUCTION TO SYNTHESIS- GRAPHICAL METHODS	10

The Four bar linkage, guiding a body through Two distinct positions, Guiding a body through Three distinct positions - Function generation- General discussion - Velocity – Pole method, Path generation: Hrones's and Nelson's motion Atlas, Roberts's theorem

UNIT III	INTRODUCTION TO SYNTHESIS – ANALYTICAL METHODS	10

Function Generation: Freudenstien's Equation, Precision point approximation, Path Generation: Synthesis of Four-bar Mechanisms for specified instantaneous condition

TOTAL: 30 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Demonstrate the principles of Coupler curves.	2
CO2	Perform synthesis for multiple specified positions of a linkage.	3
CO3	Perform kinematic analysis of a mechanical linkages	3

TEXTBOOKS:

1.	John J. Uicker, Gordon R. Pennock and Joseph E. Shigley, "Theory of Machines and Mechanisms", Oxford University Press, Fourth Edition, 2014.

REFERENCES:

1.	Amitabh Ghosh and Ashok Kumar Mallik, "Theory of Mechanisms and Machines", McGraw Hill, Fifth edition, 2019.
2.	Charles E Wilson and J. Peter Sadler, "Kinematics and Dynamics of Machinery", Pearson, Third Edition, 2008.
3.	Henry T. Brown Dover, "507 Mechanical Movements: Mechanisms and Devices", Publications Inc, First Edition, 2005.
4.	Kevin Russell, Qiong Shen and Rajpal S. Sodhi, "Kinematics and Dynamics of Mechanical Systems", Implementation in MATLAB® and SimMechanics®, ,CRC Press, Second Edition, 2018.
5.	Robert L. Norton, "Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines", McGraw-Hill, Fifth Edition, 2011.

E-RESOURCES:

1.	https://archive.nptel.ac.in/courses/112/105/112105268/

VC22001	BASICS OF ENTREPRENEURSHIP DEVELOPMENT (Common to all Branches)	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

1.	To provide Knowledge on Self-discovery and Problem identification.
2.	To provide Skill set on Identifying customer segment and Practice on Business Model.
3.	To understand the Market, Sales and support.

UNIT I	SELF-DISCOVERY & PROBLEM IDENTIFICATION	6

Orientation of Entrepreneurship – Case Study – activity – Effectuation – Principles of Effectuation – Identifying Entrepreneur skill.
Problem Identification – Design thinking – look for solution – activity – Brainstorming.

UNIT II	CUSTOMER IDENTIFICATION & BUSINESS MODEL	6

Identifying customer segment, understanding the market – Product selection –activity – value proposition canvas.
Identify the Problem, Solution and Risk identification – Activity – Business model.

UNIT III	VALIDATION AND RESOURCES	6

Build a Minimum Viable Product (MVP) – validation and launching of MVP –activity – MVP Interview.
Cost – Revenue – Pricing – Profitability – Sources of finance – activity – Bootstrap Finance – Leadership – Identifying Co-founders and Hiring a Team – activity –Pitching about a venture

UNIT IV	MARKET AND SALES	6

Positioning and branding – network and channels – sales planning – activity – selling skill.

UNIT V	SUPPORT	6

Project Management – Project tracking – Basics of Business regulations – Activity – capstone project.

TOTAL: 30 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Apply the knowledge on Self Discovery and Problem identification in real time scenarios	2
CO2	Identify the potential customer and prepare business model.	2
CO3	Develop strategies to validate MVP ideas using market research, customer feedback, and experimentation.	3
CO4	Understand the importance of positioning and branding in establishing a distinct identity and value proposition for a product or service.	3
CO5	Demonstrate the business regulations to real-world scenarios, ensuring compliance and ethical business practices.	3

TEXT BOOKS:

1.	S.S.Khanka, "Entrepreneurial Development" S.Chand & Co. Ltd., Ram Nagar, New Delhi, 2013.
2.	Donald F Kuratko," Entreprenuership – Theory, Process and Practice",9th edition, Cengage Learning 2014

REFERENCES:

1.	Hisrich R D, Peters M P, "Entrepreneurship" 8th Edition, Tata McGraw-Hill, 2013.
2.	Mathew J Manimala, "Entrepreneurship Theory at Cross Roads: paradigms and Praxis", 2nd Edition Dream Tech, 2005.

E-RESOURCES: (including NPTEL course)	
1.	https://learnwise.wfglobal.org/#/IN/en/courses

VC22002	ADVANCES IN ENTREPRENEURSHIP DEVELOPMENT (Common to all Branches)	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

1.	To provide Knowledge on Business model, Business plan and new business model/prototype.
2.	To provide Skill set on increasing revenue and funding.
3.	To understand the Team building, Measurement of progress and legal matters.

UNIT I	**BUSINESS MODEL AND PRODUCT SERVICE**	**6**

Introduction to the concept of pivoting –Business Model-Types of Business Model-Business Model Evaluation-Refining Business Model-Analyzing Business Model-Adding New customer to Business model. Problem in new product development-New business model/Prototype.

UNIT II	**BUSINESS PLANNING**	**6**

Business Plan-Sales plan- People plan- Finance plan-understanding finance planning-Forecasting template. Creating procurement plan-Negotiation role play-Activity.

UNIT III	**INCREASING REVENUE AND FUNDING**	**6**

Understanding of primary revenue source-Customer life cycle-Exploring secondary revenue source-Funding option. Exploring funding option-Pitch deck.

UNIT IV	**BUILDING A TEAM AND BRANDINGS**	**6**

Introduction to building a team-pitching to attract team-Setting a team for success-standardize key process-Branding-Definition of values-Positioning Statement-Identification of right channel-Digital marketing. Brand name and logo activity.

UNIT V	**MEASUREMENT OF PROGRESS AND LEGAL MATTERS**	**6**

Metrics for customer retention and satisfaction-Metrics dashboard-legal and compliance requirement-Identify mentor and advisors. Project.

TOTAL: 30 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Acquire knowledge and Practice on Business model.	2
CO2	Develop comprehensive business plans encompassing sales, people, and finance plans, aligned with organizational goals and market demands.	2
CO3	Explore the revenue sources to enhance the business sustainability.	3
CO4	Develop strategy for teamwork, branding, and positioning	4
CO5	Develop a metrics dashboard and analyze customer retention, legal compliance, and mentorship engagement	3

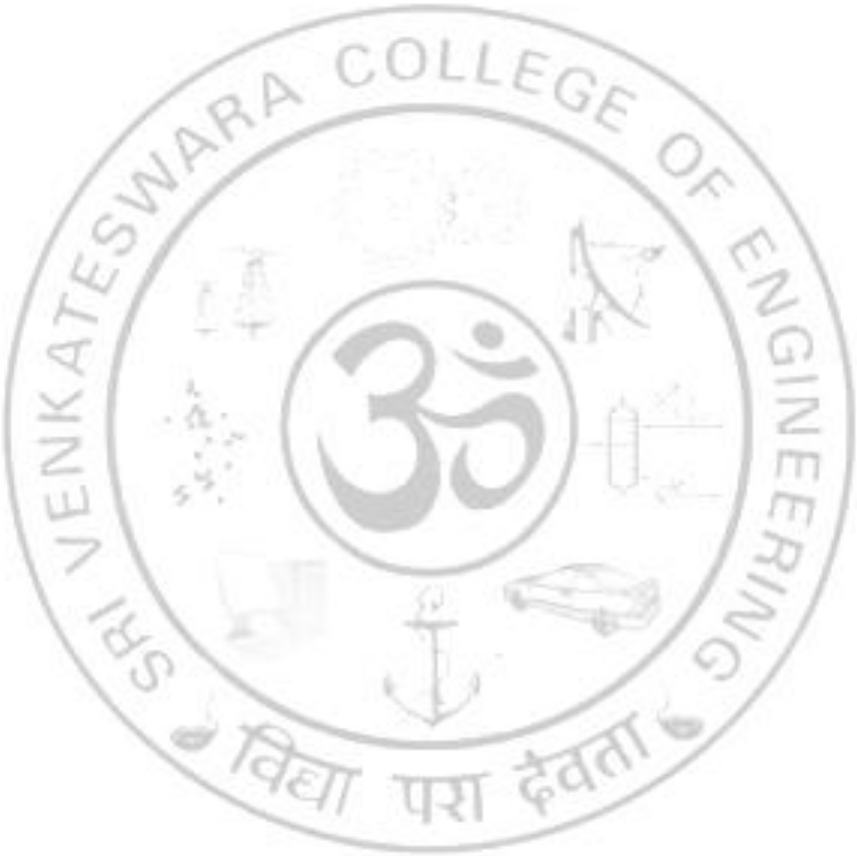
TEXTBOOKS:

1.	S.S.Khanka, "Entrepreneurial Development" S. Chand& Co. Ltd., Ram Nagar, New Delhi, 2013.
2.	Donald F Kuratko, "Entrepreneurship – Theory, Process and Practice", 9th edition, Cengage

REFERENCES:

1.	Hisrich R D, Peters M P, "Entrepreneurship" 8th Edition, Tata McGraw-Hill, 2013.
2.	Mathew J Manimala, "Entrepreneurship Theory at Crossroads: paradigms and Praxis", 2nd Edition Dream Tech, 2005.

E-RESOURCES: (including NPTEL course)	
1.	https://lms.learnwise.wfglobal.org/IN/en/home



VC22006	DESIGN THINKING AND PROTOTYPING LABORATORY (Common to all Branches)	L	T	P	C
		1	0	2	0

COURSE OBJECTIVES:

1.	Introduce students to CAD software and its role in additive manufacturing, focusing on 3D modeling techniques and file conversion.
2.	Provide hands-on experience in utilizing slicing software to analyze and adjust process parameters for optimized 3D printing outcomes.
3.	Foster critical thinking skills through practical exercises and projects aimed at applying learned concepts to real-world engineering design challenges

LIST OF EXPERIMENTS

1. Modelling of Engineering components and conversion of STL format.
2. Working with CAD Data Exchange formats: IGES, ACIS, DXF STL, AMF.
3. Slicing of STL file and study of effect of process parameter like layer thickness, Orientation and infill on build time using software.
4. 3D Printing of modelled component by varying layer thickness.
5. 3D Printing of modelled component by varying orientation.
6. 3D Printing of modelled component by varying infill
7. Study the effect of different materials like ABS, PLA, Resin etc, and dimensional accuracy.
8. Modelling of component using generative design with optimal strength to weight ratio.
9. Modelling of components using various measuring instruments and CMM of real-life object of unknown dimension in reverse engineering.

TOTAL: 45 PERIODS

CO No	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Understand CAD modeling principles and convert between CAD formats and STL for 3D printing applications	3
CO2	Analyze and optimize process parameters such as layer thickness, orientation, and infill to enhance efficiency and quality in additive manufacturing.	4
CO3	Develop expertise in utilizing 3D printing technology to materialize CAD models into physical components	4

TEXTBOOKS:

1.	Sham Tickoo, "Creo Parametric for Engineers and Designers", CADCIM Technologies, 2022. (ISBN-13: 978-1640571608)
2.	Kuang-Hua Chang, "Introduction to Creo Parametric 8.0", SDC Publications, 2023. (ISBN-13: 978-1630575193)
3.	Richard Horne, "3D Printing for Dummies", For Dummies, 2022. (ISBN-13: 978-1119718243)
4.	Joan Horvath, Rich Cameron," Mastering 3D Printing - A Guide to Modeling, Printing, and Prototyping", Apress,2020