

B.E MECHANICAL ENGINEERING**Regulations 2019****VISION AND MISSION OF THE DEPARTMENT****Vision**

The Mechanical Engineering Department strives to be recognized nationally for outstanding education and research leading to well-qualified engineers, who are innovative, entrepreneurial and successful in fields of engineering.

Mission

- M1** Imparting quality education to the students and enhancing their skills to make them globally competitive Mechanical Engineers.
- M2** Maintaining vital, state-of-the-art laboratory facilities to provide its students with opportunities to create, interpret, apply and disseminate knowledge.
- M3** To develop linkages with research organizations and educational institutions in India for excellence in teaching, research and consultancy practices.
- M4** To provide the students with academic environment of excellence, leadership, ethical guidelines and lifelong learning needed for a long productive career.

Programme Outcomes (POs):

- PO1 Engineering Knowledge:** Apply the knowledge of mathematics, science and engineering fundamentals to find the solution for complex Mechanical engineering problems
- PO2 Problem analysis:** Identify, formulate, review research literature, and analyze complex mechanical engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
- PO3 Design and development of solutions:** Design solutions for complex engineering problems or system components or processes related to Mechanical Engineering that meet the specified needs with appropriate consideration for the public health and safety, the cultural, societal, and environmental considerations.
- PO4 Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments in Mechanical Engineering, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

- PO5 Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and Information Technology tools including prediction and modelling to complex engineering problems in Mechanical Engineering with an understanding of the limitations.
- PO6 The engineer and society:** Apply contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
- PO7 Environment and sustainability:** Understand the impact of professional Production and Industrial Engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development
- PO8 Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- PO9 Individual and team work:** Function effectively as an individual and as a member or leader in diverse teams as well as in multidisciplinary settings.
- PO10 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.
- PO11 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.
- PO12 Lifelong learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Programme Educational Objectives (PEOs)

The following Programme Educational Objectives are designed based on the department Mission

- PEO1** The graduates will be able to apply the overall knowledge of Mechanical Engineering along with concepts of Mathematics, Science, Communication and Computing skills to understand specific problem areas and finding the optimal solutions for the same.
- PEO2** The graduates will be able to implement ideas of Mechanical Engineering for the challenging tasks in the interdisciplinary areas like Electrical, Electronics, Computer Science, Civil and allied branches.
- PEO3** The graduates will be widely talented in the field of manufacturing, design and service industries which will not only improve their employability but also aid in establishing the above said industries.
- PEO4** The graduates will develop lifelong learning attitudes, ethics and values that will help their career employability and growth in engineering, academia, defence, state and central government sectors.

Programme Specific Outcomes (PSOs)

- PSO1** Specify, fabricate, test and operate various machines along with essential documentations
- PSO2** Analyze, design, develop and implement the concepts of mechanical systems and processes towards product development

Mapping PEOs, POs & PSOs

PEOs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
PEO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3
PEO2	3	3	3	3	3	2	1	1	2		2	1	3	3
PEO3	3	2	2	2	2		2				1	1	2	2
PEO4	3	2	2	2	1	3	2	2	2	1	1	3	2	2
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

Course Code	Course Title	Periods / week			Credits	CAT
		Lecture	Tutorial	Practical		
SEMESTER 1						
U19EGE01	Technical English	2	0	2	3	HS
U19MAT01	Engineering Mathematics - I	3	1	0	4	BS
U19CYE01	Applied Chemistry	3	0	2	4	BS
U19MET01	Engineering Graphics	2	0	4	4	ES
U19ECT01	Elements of Electrical, Electronics and Information Sciences	3	0	0	3	ES
U19EEP01	Engineering Practices laboratory	0	0	4	2	ES
U19MTA01	Induction Program*	0	0	0	0	MC
Total : 26 Periods		13	1	12	20	
SEMESTER 2						
U19EGE02	Communicative English	2	0	2	3	HS
U19MAT02	Engineering Mathematics - II	3	1	0	4	BS
U19PYE02	Applied Physics	3	0	2	4	BS
U19MET03	Engineering Mechanics	3	1	0	4	ES
U19CSE01	Problem Solving and Python Programming	3	0	2	4	ES
U19MEP01	Computer Aided Drafting Laboratory	0	0	4	2	ES
Total : 26 Periods		14	2	10	21	
SEMESTER 3						
U19MAT04	Transforms and Boundary Value Problems	3	1	0	4	BS
U19MET04	Manufacturing Technology I	3	0	0	3	PC
U19MET05	Engineering Thermodynamics	3	1	0	4	PC
U19MEE01	Strength of Materials	2	1	2	4	PC
U19MEE02	Fluid Mechanics and Machinery	2	1	2	4	ES
U19MEP02	Computer Aided Machine Drawing Laboratory	0	0	4	2	ES
Total : 25 Periods		13	4	8	21	
SEMESTER 4						
U19MAT08	Statistics and Numerical Methods	3	1	0	4	BS
U19MEE03	Kinematics of Machinery	2	1	2	4	PC
U19MET06	Engineering Materials and Metallurgy	3	0	0	3	PC
U19MEE04	Thermal Engineering	2	1	2	4	PC
U19MET07	Manufacturing Technology II	3	0	0	3	PC
U19MEP03	Manufacturing Technology Laboratory	0	0	4	2	PC
U19MTT01	Environmental Science*	2	0	0	0	MC
Total : 26 Periods		15	3	8	20	

* As per norms

CAT - Category; BS - Basic Science; HS - Humanities and Social Science; ES - Engineering Science;

PC - Professional Core; PE - Professional Electives; OE - Open Electives; EEC - Employability Enhancement Course;

MT – Mandatory Course

Course Code		Course Title	Periods / week			Credits	CAT
			Lecture	Tutorial	Practical		
SEMESTER 5							
U19MEE05	Dynamics of Machinery	2	1	2	4	PC	
U19MEE06	Heat and Mass Transfer	2	1	2	4	PC	
U19MET08	Design of Machine Elements	2	1	0	3	PC	
U19MET09	Automobile Engineering	3	0	0	3	PC	
U19_____	Open Elective I	3	0	0	3	OE	
U19ME__	Professional Elective I	3	0	0	3	PE	
U19MTT02	Indian Constitution*	2	0	0	0	MC	
Total : 24 Periods		17	3	4	20		
SEMESTER 6							
U19MEE07	Metrology and Measurements	3	0	2	4	PC	
U19MET10	Design of Transmission Elements	2	1	0	3	PC	
U19MEE08	Finite Element Analysis	3	0	2	4	PC	
U19ME__	Professional Elective II	3	0	0	3	PE	
U19_____	Open Elective II	3	0	0	3	OE	
U19MEJ01	Design and Fabrication Project	0	0	6	3	EEC	
Total : 25 Periods		14	1	10	20		
SEMESTER 7							
U19MET11	Total Quality Management	3	0	0	3	HS	
U19ME__	Professional Elective III	3	0	0	3	PE	
U19ME__	Professional Elective IV	3	0	0	3	PE	
U19ME__	Professional Elective V	3	0	0	3	PE	
U19_____	Open Elective III	3	0	0	3	OE	
U19MEP04	Automation Laboratory	0	0	4	2	PC	
U19MEJ02	Project Work Phase I	0	0	4	2	EEC	
Total : 23 Periods		15	0	8	19		
SEMESTER 8							
U19MET12	Principles of Management	3	0	0	3	HS	
U19_____	Open Elective IV	3	0	0	3	OE	
U19ME__	Professional Elective VI	3	0	0	3	PE	
U19MEJ03	Project Work Phase II	0	0	16	8	EEC	
U19MEI01	Industrial Practice / In-plant Training	0	0	4	2	EEC	
Total : 29 Periods		9	0	20	19		

* As per norms

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PC - Professional Core; PE - Professional Electives; OE - Open Electives; EEC - Employability Enhancement Course;

Course code	Course Title
U19MET50	Design Thinking
U19MET51	Renewable energy sources and systems
U19MET52	Power Plant Engineering
U19MET53	Gas Dynamics and Jet Propulsion
U19MET54	Refrigeration and Air-conditioning
U19MET55	Alternative Fuels for IC Engines
U19MET56	Hybrid Electric Vehicles
U19MET57	Hydrogen and Fuel Cell Technology
U19MET58	Fuels and Combustion
U19MET59	Welding Technology
U19MET60	Additive Manufacturing
U19MET61	Lean Manufacturing
U19MET62	Process Planning and Cost Estimation
U19MET63	Automated Manufacturing System
U19MET64	Plastic Engineering
U19MET65	Maintenance Engineering
U19MET66	Non - Traditional Machining Processes

Course code	Course Title
U19MET67	Supply Chain Management
U19MET68	Marketing Management
U19MET69	Industrial Engineering
U19MET70	Internet of Things for Mechanical Applications
U19MET71	Failure Analysis in Design
U19MET72	Concept of Engineering Design
U19MET73	Computational Fluid Dynamics
U19MET74	Design of Jigs, Fixtures and Press Tools
U19MET75	Design for Manufacturing and Assembly
U19MET76	Product Design
U19MET77	Computer Aided Design
U19MET78	Micro Electro Mechanical System
U19MET79	Composite Materials
U19MET80	Wire Arc Additive Manufacturing
U19MET81	Hydraulics and Pneumatics
U19MET82	Entrepreneurship Development
U19MET83	Mechatronics
U19MET84	Professional Ethics in Engineering
U19MET85	Operations Research
U19MET86	Human Rights
U19MET87	Non-Destructive Testing and Evaluation
U19MET88	Industrial Safety and Environment
U19MET89	Intellectual Property Rights

SUMMARY OF CREDIT DISTRIBUTION

CAT	Credits /Semeste								Total Credits
	I	II	III	IV	V	VI	VII	VIII	
HS	3	3	0	0	0	0	3	3	12
BS	8	8	4	4	0	0	0	0	24
ES	9	10	6	0	0	0	0	0	25
PC	0	0	11	16	14	11	2	0	54
PE	0	0	0	0	3	3	9	3	18
OE	0	0	0	0	3	3	3	3	12
EEC	0	0	0	0	0	3	2	10	15
Total	20	21	21	20	20	20	19	19	160

* As per norms

CAT - Category; BS - Basic Science; HS - Humanities and Social Science; ES - Engineering Science;

PC - Professional Core; PE - Professional Electives; OE - Open Electives; EEC - Employability Enhancement Course;

MT – Mandatory Course

Mapping of Course Outcome and Programme Outcome

Year	Sem	Course Title	Programme Outcomes (POs)												PSOs	
			1	2	3	4	5	6	7	8	9	10	11	12	1	2
I	I	Technical English	3	1	2	-	2	-	-	-	-	3	-	2	1	1
		Engineering Mathematics - I	2.1	2.1	2.1	-	-	-	-	--	1.6	-	-	1	1	2
		Applied Chemistry	2.6	1.6	1	-	-	-	0.2	-	-	-	-	-	1	1
		Engineering Graphics	3	1	2	-	2	-	--	-	-	3	-	2	2	2
		Elements of Electrical, Electronics and Information Sciences	2.4	2.2	1	1.8	-	-	-	-	-	-	0.4	1.8	0.4	0.6
		Engineering Practices laboratory	3	2	-	-	1	1	1	--	-	-	-	2	1	1
		Induction Program*	-	-	-	-	-	--	-	-	-	-	-	-	-	-
	II	Communicative English	3	1	2	-	2	-	-	-	-	3	-	2	1	1
		Engineering Mathematics - II	2.2	2	2	-	-	-	-	-	1.6	-	-	1	1	1
		Applied Physics	2	2.2	1.8	1	-	-	-	-	-	-	-	0.2	1	1
		Engineering Mechanics	3	2	3	1	2	-	-	-	-	-	-	2	3	1
		Problem Solving and Python Programming	3	3	3	3	2	1.6	1	1	2	2	1.4	3	1	1
		Computer Aided Drafting Laboratory	2	3	2	2	1	1	-	1	1	1	1	1	2	2
II	III	Transforms and Boundary Value Problems	3	3	1	1	-	-	-	--	2	-	-	3	2	1
		Manufacturing Technology I	3	1	2	1	-	2	3	1	1	-	-	1	3	1
		Engineering Thermodynamics	3	3	2	2	-	1	-	--	2	-	1	2	3	2
		Strength of Materials	3	3	3	3	2	3	1	3	2	3	1	3	2	2
		Fluid Mechanics and Machinery	3	3	3	2.4	1	2	2	1	2	1	1	2	3	2
		Computer Aided Machine Drawing Laboratory	1	2	-	-	3	-	-	-	3	2	-	3	2	2
	IV	Statistics and Numerical Methods	3	3	1	1	-	-	-	-	2	-	-	3	1	1
		Kinematics of Machinery	3	2	2	-	2	-	-	1	-	-	-	1	3	1
		Engineering Materials and Metallurgy	3	3	3	3	2	2	1	3	2	3	1	3	2	2
		Thermal Engineering	3	2	2	1	-	-	-	-	-	-	-	1	2	1
		Manufacturing Technology II	3	3	3	1	1	1	3	-	-	3	-	2	3	2
		Manufacturing Technology Laboratory	3	-	-	-	-	-	-	1	-	2	-	1	1	2
		Environmental Science*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III	V	Dynamics of Machinery	3	2	2	-	2	-	-	1	-	--	-	1	3	1
		Heat and Mass Transfer	3	3	3	2	-	-	-	-	1	-	-	1	3	2
		Design of Machine Elements	3	3	3	--	-	-	-	1	1	-	-	2	3	2
		Automobile Engineering	2	1	2	1	-	-	-	-	1	-	-	1	2	1
		Indian Constitution*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	VI	Metrology and Measurements	3	2	2	2	-	-	-	-	1	-	-	1	3	2
		Design of Transmission Elements	3	2	3	1	-	-	-	-	1	-	-	2	3	2
		Finite Element Analysis	3	2	2	2	2	-	-	-	1	1	-	2	2	1
		Professional Elective II														
		Open Elective II														
IV	VII	Total Quality Management	3	-	-	3	3	3	-	2	3	2	-	-	2	2
		Automation Laboratory	3	1	3	1	3	-	-	-	3	-	-	3	1	1
		Project Work Phase I														
	VIII	Principles of Management	3	-	-	3	3	3	-	2	3	2	-	-	2	2
		Project Work Phase II														

Year	Sem	Course Title	Programme Outcomes (POs)												PSOs	
			1	2	3	4	5	6	7	8	9	10	11	12	1	2
Professional Elective	V	Design Thinking	1	1	1	1	2	-	-	-	1	3	-	2	2	1
		Hydrogen and Fuel Cell Technology	3	2	1	1	1	-	1	-	-	-	-	1	1	1
		Alternative Fuels for IC Engines	3	2	1	1	1	-	1	-	-	-	-	1	1	1
		Wire Arc Additive Manufacturing	2	1	1	1	1	-	1	-	-	-	-	1	1	1
		Gas Dynamics and Jet Propulsion	3	2	1	1	-	-	-	-	1	-	-	1	3	1
		Refrigeration and Air-conditioning	2	1	1	1	-	-	2	-	1	-	-	1	2	2
	VI	Renewable energy sources and systems	3	2	2	1	1	1	3	1	1	1	1	3	2	1
		Automated Manufacturing System	3	2	2	1	2	-	-	-	1	-	-	1	2	1
		Plastic Engineering	3	2	1	1	1	-	1	-	-	-	-	1	2	1
		Supply Chain Management	1	1	2	-	-	-	2	-	1	-	3	1	2	1
		Marketing Management	1	1	-	-	-	-	1	1	1	1	1	1	-	-
		Industrial Engineering	2	3	2	3	-	-	-	-	1	-	-	1	2	1
	VII	Hybrid Electric Vehicles	3	2	1	1	1	-	2	-	-	-	-	-	2	1
		Maintenance Engineering	3	2	1	-	-	-	1	-	-	-	-	1	1	1
		Internet of Things for Mechanical Applications	3	2	1	1	1	-	-	1	1	1	-	1	2	1
		Failure Analysis in Design	2	2	1	2	2	-	-	-	1	-	-	1	2	1
		Concept of Engineering Design	2	2	2	2	-	-	-	-	1	-	-	-	2	1
		Mechatronics	3	2	1	3	-	2	-	-	-	-	-	2	3	2
		Fuels and Combustion	2	2	1	1	1	-	-	-	-	-	-	1	1	1
		Welding Technology	2	2	2	2	-	-	-	-	1	-	-	1	2	2
		Additive Manufacturing	3	2	2	2	1	-	-	-	1	-	-	1	3	2
		Lean Manufacturing	1	1	2	1	1	-	-	-	1	-	3	1	2	1
		Process Planning and Cost Estimation	3	2	2	2	-	-	-	-	1	-	1	1	2	1
		Non - Traditional Machining Processes	2	1	2	-	-	2	1	-	-	-	-	1	2	1
		Computational Fluid Dynamics	3	2	1	1	-	-	-	-	1	-	-	1	3	2
		Design of Jigs, Fixtures and Press Tools	3	3	3	1	1	-	-	-	1	-	-	1	2	2
	VIII	Power Plant Engineering	3	1	1	1	-	1	3	-	-	1	-	1	2	2
		Industrial Safety and Environment	1	2	2	1	2	2	1	1	1	1	1	2	2	2
		Intellectual Property Rights	3	3	-	2	-	-	2	2	-	2	-	-	-	-
		Design for Manufacturing and Assembly	3	3	3	1	-	-	-	-	-	-	-	1	2	2
		Product Design	1	1	3	1	-	-	-	1	1	-	-	1	2	1
		Computer Aided Design	1	1	1	1	2	-	-	-	1	3	-	2	2	1
		Micro Electro Mechanical System	3	2	2	1	1	-	1	-	1	-	-	1	2	2
		Composite Materials	2	2	2	2	-	2	2	-	-	-	-	2	3	-
		Hydraulics and Pneumatics	2	1	1	1	-	-	-	-	-	-	-	1	2	1
		Entrepreneurship Development	3	1	1	1	-	1	1	1	-	-	-	2	1	1
		Professional Ethics in Engineering	1	1	-	-	-	1	1	3	1	1	-	1	-	-
		Operations Research	2	3	3	2	2	1	1	1	1	1	2	2	2	2
		Human Rights	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Non-Destructive Testing and Evaluation	2	2	1	2	2	-	-	-	1	-	-	1	2	1

Semester 1

Pre-Requisites : None

Objectives:

To make the students to

- learn technical and non- technical vocabulary in speaking and writing
- read and comprehend engineering and technical texts
- learn the required format for business and official communication
- familiarize technical communication portfolio
- practice to speak and write in English

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1 : use more technical and non- technical vocabulary in speaking and writing

CO2 : read and comprehend engineering and technical texts

CO3 : the required format for business and official communication

CO4 : apply technical communication portfolio wherever necessary

CO5 : will be able to speak and write in English

Unit I INTRODUCTION TO TECHNICAL ENGLISH 9

Listening: Listening to scientific and technical talks. Speaking: Self Introduction, introducing others. Reading: Skimming and scanning the text and finding the answers for the given questions. Writing: Parts of speech, word Formation- prefix and suffix, One word Substitutes, , Synonyms & Antonyms, Countable and Uncountable Nouns, technical Paragraph Writing, short essays related to various fields of engineering.

Unit II WORDS AND SENTENCES 9

Listening: Listening to longer technical talks and completing exercises based on that. Speaking: Describing a process, Reading: Note making on the given text. Writing: Matching words and phrases, Different forms of words, Types of sentences, Direct and Indirect Speech. instructions, Recommendations.

Unit III ENGLISH FOR BUSINESS COMMUNICATION 9

Listening: Listening to talks on latest technology. Speaking: Giving summary of an article. Reading; Reading technical texts Journals/ Articles. Writing; - tenses, question tags. Writing reports, report on various projects, Formal Letter- business letter- calling for quotation, placing orders.

Unit IV TECHNICAL COMMUNICATION PORTFOLIO 9

Listening: Listening to documentaries. Speaking: Discussion on the documentaries related to the documentaries listened. Reading: Reading for technical information and comprehending. Writing: Gerund, Technical vocabulary, 'If' conditionals, Expansion of compound nouns, writing notice, e-mails, Agenda & Minutes of Meeting.

Unit V ESSENTIAL SOFTSKILLS FOR ENGINEERS 9

Listening: Listening to TED talks. Speaking: Group Discussion. Reading; Pre Reading and post reading and answering comprehension questions. Writing: Gap fillers, Punctuation for effective writing, collocations, Active and Passive voice, Formal Letter- official letter Article Writing for journals

Total Periods: 45

List of Exercise:

1. Listening to scientific and technical talks
2. Speaking: Self Introduction, introducing others
3. Listening to longer technical talks and completing exercises based on that.

- Text Books:**

Reference Books:

Web URL(s):

- | COs | POs | | | | | | | | | | | | PSOs | |
|---|-----|---|---|---|---|---|---|---|---|----|----|----|------|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 |
| CO1 | 3 | 1 | 2 | | 2 | | | | | 3 | | 2 | | |
| CO2 | 3 | 1 | 2 | | 2 | | | | | 3 | | 2 | | |
| CO3 | 3 | 1 | 2 | | 2 | | | | | 3 | | 2 | | |
| CO4 | 3 | 1 | 2 | | 2 | | | | | 3 | | 2 | | |
| CO5 | 3 | 1 | 2 | | 2 | | | | | 3 | | 2 | | |
| <div> <div>1 - Reasonably agreed</div> <div>2 - Moderately agreed</div> <div>3 - Strongly agreed</div> </div> | | | | | | | | | | | | | | |

Pre-Requisites : Concepts of basic matrices, differentiation and integration

Objectives:

- Interpret the introductory concepts of matrices which will enable the students to model and analyze physical phenomenon involving the multidimensional variable.
- Demonstrate the methodologies involved in solving problems using Jacobian method(at later stage).
- Understand differential calculus through geometrical interpretation.
- Exemplify the concepts of integration through various techniques.
- Develop enough confidence to identify the modern mathematical pattern in real world and offer an appropriate solution using the skills learned in their interactive and supporting environment.

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1 : Apply the knowledge of matrices to solve the problems for respective areas of specialization

CO2 : Implement the various differentiation and integral techniques in solving the system.

CO3 : Apply the knowledge of calculus that are essential for engineering and technology.

CO4 : Explore the basic concepts of integration methods through geometrical representation.

CO5 : Evaluate the functions to get the surface area and volume using multiple integrals.

Unit I MATRICES

9+3

Linear Independence and dependence, Determinant, Gramer's rule. Eigen values and eigenvectors of a real matrix, Properties of eigenvalues and eigenvectors, Cayley – Hamilton theorem (statement), Orthogonal matrices, Application-Elastic Membrane.

Unit II FUNCTIONS OF SEVERAL VARIABLES

9+3

Limits and Continuity(Geometrical interpretations) –Properties of continuous function – Partial derivatives-Total derivatives- Jacobians - Taylor's series for two variables.

Unit III DIFFERENTIAL CALCULUS

9+3

Curvature of a curve (Cartesian co-ordinates) , centre and radius of curvature , circle of Curvature, Cartesian co-ordinates -Evolutes, Envelopes of family of curves.

Unit IV INTEGRATION METHODS

9+3

Basic integration formulae for algebraic and transcendental functions- Integration by special devices : Integration by parts – rationalizing substitution or trigonometric substitution-partial fraction – reduction formula's – Improper integrals.

Unit V MULTIPLE INTEGRALS

9+3

Double integration(Cartesian coordinates)-Region of integration, Triple integration in Cartesian Coordinates -Meaning and Application.

Total Periods 45+15

Text Books:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	B.S.Grewal	Higher Engineering Mathematics,	Khanna Publishers,43rd EditionDelhi	2015
2.	E.Kreyszig	Advanced Engineering Mathematics,	John Wiley and Sons(Asia)Ltd,Tenth Edition. Singapore	2015

Reference Books:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Glyn James	Advanced Modern Engineering Mathematics	Wiley India	2014
2.	Samantha Pal, Subodha .C.Bhunia	Engineering Mathematics	Oxford University	2015
3.	C.Ray.Wylie, Loui's C.Barrett	Advanced Engineering Mathematics, 6 th edition	McGrawhill, 6 th edition, New Delhi	2014

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

	APPLIED CHEMISTRY	L	T	P	C
U19CYE01	(Common to CIVIL, MECH and MCT)	3	0	2	4

Pre-Requisites : None

Objectives:

To make the students

- understand the requirements of Boiler feed water, its problems and water treatment methods.
- familiar with the manufacture and properties of various engineering materials.
- learn the principles and generation of energy in solar cells, fuel cells and batteries.
- understand the basic concepts of phase rule and its application to one and two component systems and appreciate the purpose and significance of alloys.
- familiar with the nature of fuels and its combustion

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1 : explain the various water treatment process, which make it fit for industrial and domestic purpose.

CO2 : explain methods involved in the synthesis of different engineering materials and its properties.

CO3 : analyse various sources of energy and its storage in different batteries, which find its application in society including engineering fields.

CO4 : explain the principles involved in alloying metals and also its properties.

CO5 : analyse the combustion characteristics in engines and apply them in the design of combustion chambers.

Unit I WATER TECHNOLOGY 9

Hardness of water-types -expression-units-estimation of hardness of water by EDTA-numerical problems-boiler feed water-disadvantages of hard water in boilers-boiler troubles (scale & sludge, boiler corrosion)-water treatment- zeolite process, Ion exchange process-desalination-reverse osmosis-instrumental methods for water analysis-AAS, flame emission spectroscopy and photocolorimetry.

Unit II ENGINEERING MATERIALS 9

Refractories-classification-properties (refractoriness, RUL, dimensional stability, thermal spalling, thermal expansion, porosity)-manufacture of silica and magnesite bricks-Abrasives-classification-properties-manufacture of SiC, alundum, norbide-Portland Cement-manufacture (wet process)-properties-setting and hardening of cement- special cement-alumina cement and water proof cement.

Unit III ENERGY SOURCES AND STORAGE DEVICES 9

Energy sources-types-nuclear energy-nuclear fission-controlled nuclear fission-nuclear fusion-nuclear reactor power generator-breeder reactor-solar energy-solar energy conversion-wind energy-Batteries - primary (alkaline battery) - Secondary (lead storage battery, NICAD battery and lithium ion battery)-Fuel cells (H_2-O_2 , direct methanol and solid oxide)-super capacitors.

Unit IV PHASE RULE AND ALLOYS 9

Phase Rule: Introduction-definition of terms with examples-one component system-water system-reduced phase rule – thermal analysis and cooling curves-two component system-lead-silver system-pattinson process.

Alloys: Introduction-definition-properties of alloys-significance of alloying, functions and effect of alloying elements-ferrous alloys (Nichrome and Stainless steel)-Heat treatment of steel-non ferrous alloys (Brass andBronze).

Unit V FUELS AND COMBUSTION 9

Fuels: Introduction-classification of fuels-coal-analysis of coal (proximate and ultimate)-carbonization- manufacture of metallurgical coke (Otto Hoffmann method)-petroleum-manufacture of synthetic petrol (Bergius process)-knocking-octane number-diesel oil-cetane number-natural gas-compressed natural gas (CNG)-liquefied petroleum gases (LPG)-power alcohol and bio diesel.

Combustion of fuels: Introduction-HCV and LCV-theoretical calculation of calorific value-ignition temperature-explosive range-flue gas analysis (gas chromatography).

Total Periods 45

List of Experiments:

1. Estimation of Total, Temporary and Permanent Hardness of Water Sample by EDTA method.
2. Determination of DO content in Water by Winkler's method.
3. Determination of strength of acids in a mixture using conductivity meter.
4. Determination of strength of an acid using pH meter.
5. Estimation of iron content of the given solution using potentiometer.
6. Determination of calcium oxide in cement.
7. Estimation of Iron in a given sample by photocolourimetry

Text Books:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Jain P.C. and Monica Jain	Engineering Chemistry, 16 th edition	Dhanpat Rai Publishing Company (P) Ltd., New Delhi.	2017
2.	O.G.Palanna	Engineering Chemistry, 2 nd edition	McGraw Hill Education (India) Pvt. Ltd., Chennai.	2017

Reference Books:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Dara S.S Umare S.S	Engineering Chemistry, 12 th edition	S.Chand & Company Ltd., New Delhi	2013
2.	Sivasankar.B	Engineering Chemistry	Tata McGraw-Hill Publishing Company, Ltd., NewDelhi	2008
3.	S.Vairam P.Kalyani Suba Ramesh	Engineering Chemistry	Wiley India Pvt. Ltd, New Delhi, 1 st Reprint	2014

Web URL(s):

<http://www.erforum.net/2016/01/engineering-chemistry-by-jain-and-jain-pdf-free-ebook.html>

<https://www.mhhe.com/palanna/ec2e>

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

U19MET01

Engineering Graphics
(Common to MECH, MCT and CIVIL)

L	T	P	C
2	1	2	4

Pre-Requisites : Nil

Objectives:

- To develop in students, graphic skills for communication of concepts, ideas and design of engineering products.
- To expose them to existing national standards related to technical drawings.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Perform free hand sketching of basic geometrical constructions and multiple views of objects
- CO2 :** Do orthographic projection of lines and plane surfaces
- CO3 :** Draw projections and solids and development of surfaces
- CO4 :** Prepare isometric and perspective sections of simple solids.
- CO5 :** Demonstrate computer aided drafting.

Unit I PLANE CURVES

9

Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves.

Unit II PROJECTION OF POINTS, LINES AND PLANE SURFACES

9

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to one principal plane - Determination of true lengths and true inclinations by rotating line method. Projection of planes (polygonal and circular surfaces) inclined to one principal plane by rotating object method.

Unit III PROJECTION OF SOLIDS

9

Projection of simple solids like prisms, pyramids, cylinder, cube and cone when the axis is inclined to one of the principal planes by rotating object method

Unit IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES

9

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple solids – Prisms, pyramids, cylinders and cones

Unit V FREE HAND SKETCHING, ISOMETRIC AND PERSPECTIVE PROJECTIONS

9

Free Hand sketching: Visualization principles –Representation of Three-Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects. Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions and conversion of orthographic views to isometric. Introduction to perspective projection of simple solids- Prisms, pyramids and cylinders

Total Periods 45

Text Books:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Venugopal K. and Prabhu Raja V	“Engineering Graphics”	New Age International (P)Limited	2008.
2.	Natrajan K.V.,	A text book of Engineering Graphics	Dhanalakshmi PublishersChennai,	2009

Reference Books:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Bhatt N.D. and Panchal V.M	Engineering Drawing	Charotar Publishing House50 th Edition,	2010.
2.	Gopalakrishna K.R.,	“Engineering Drawing”(Vol. I&II combined),	Subhas Stores Bangalore,	2007
3.	Luzzader, Warren.J. and Duff,John M	“Fundamentals of Engineering Drawing with an introduction toInteractive Computer Graphics for Design and Production	Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi.	2005

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

U19ECT01	ELEMENTS OF ELECTRICAL, ELECTRONICS AND INFORMATION SCIENCE	L	T	P	C
	(Common to Mechanical, Civil, Mechatronics)	3	0	0	3

Pre-Requisites : Mathematics and Physics at 10+2 level or equivalent level

Objectives:

- To understand the fundamental concepts of circuit elements, electrical connections, laws and networks.
- To realize the operational behaviour of semiconductor devices
- To impart the concepts of digital electronics.
- To categorize various types of communication systems.
- To Familiar with the concepts in Emerging fields of computer science.

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1 : Apply knowledge of fundamental concepts of circuits in engineering domains

CO2 : Understand and apply the concepts of semiconductor devices in engineering field

CO3 : Apply knowledge of digital electronics in engineering domain

CO4 : Understand different communication systems

CO5 : Get an exposure about various emerging areas

Unit I Electric Circuits 9

Circuit Elements – Voltage, Current, Power and Energy, R, L and C - Series and parallel connections, Energy Sources, Source Transformation, Voltage division, Current division, Ohm's Law, Kirchhoff's Law – Voltage law, Current Law. Star and Delta Transformation, Power in series and parallel circuit

Unit II Analog Electronics 9

Diode - Characteristics & Applications (Zener Diode, LED, Photo diode Rectifier, Clipping circuits,). BJT Transistor and its configuration, Transistor applications. Op-amps characteristics-Inverting and Non-inverting amplifier-Instrumentation amplifier as signal conditioning Circuit

Unit III Digital Electronics 9

Introduction to numbers systems, basic Boolean laws, logic gates. Universal gates, Combinational circuit (Half-Adder, Full-Adder, Decoder), Sequential Circuit - Latch, Flip-Flop, Counters and Registers, Introduction to CMOS- Design of Universal gates using CMOS logic

Unit IV Communication Fundamentals 9

Analog Communication-Need for Modulation- AM and FM modulation. Introduction to Digital Communication-Sampling and Quantization-PCM; Digital Modulation -ASK, FSK, PSK. Introduction to Wireless Technology-Wifi, ZigBee, Bluetooth

Unit V Computer and Information Technology 9

Introduction: Artificial Intelligence, Cloud Computing, Big data Analysis, Parallel Computing, Cyber Security, Machine Learning, IoT

Total Periods: 45

Text/ Reference Books:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Sudhakar A, Shyammohan S Pillai	Circuits and Networks Analysis and Synthesis	TMGH	2011
2.	Robert L. Boylestad, Louis Nasheresky	Electronic Devices and Circuit Theory	Pearson Education	2013
3.	M. Morris Mano, Michael D. Ciletti	Digital Design, With an Introduction to the Verilog HDL	Pearson	2013
4.	Wayne Tomasi	Electronic Communication Systems	Pearson Education	2004

Web URL(s):

1. <https://nptel.ac.in/courses>
2. www.electronics-tutorials.ws/dccircuits/dcp_6.html
3. https://www.mrt.ac.lk/web/sites/default/files/elect/files/EE201_network_theorems_Nov07.pdf

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

U19EEP01

**Engineering Practices Laboratory
(Common to all Departments)**

L	T	P	C
0	0	4	2

Pre-Requisites : Nil

Objectives:

- To know about the usage of appropriate tools and equipment's used in plumbing and carpentry
- To acquaint metal joining process
- To understand working methodologies in lathe and sheet metal.
- To impart knowledge in electrical wiring concepts for house hold and calculations of power and energy.
- To familiarize with various electronic components and equipments.
- To learn the basic skills of soldering electronic components and wires

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1:** Use proper tools for plumbing and carpentry
- CO2 :** Join metals using arc welding
- CO3 :** Create models in sheet metal and perform basic machining operations in lathe
- CO4 :** Carry out basic home electrical works and measure electrical quantities
- CO5 :** Possess the knowledge on various electronics components and equipments
- CO6 :** Elaborate on soldering practices

List of Experiments:

MECHANICAL AND CIVIL EENGINEERING PRACTICES

1. Study of plumbing and carpentry components of residential and industrial building
2. Hands-on-exercise: Wood work, joints by sawing, planning and cutting
3. Preparation of butt joints, lap joints and T- joints by metal arc welding
4. Study of Lathe, centrifugal pump and air conditioner
5. Hands-on-exercise: Simple Turning, Taper Turning and Drilling Practice
6. Sheet Metal Works: Model making – Trays and funnels

ELECTRICAL AND ELECTRONICS ENGINEERING PRACTICES

1. Residential house wiring and staircase wiring.
2. Measurement of power and energy
3. Measurement of earth resistance
4. Study of different types of electronic components resistors, capacitors, inductors, function generator and DC power supply.
5. Study of CRO and measurement of AC signal parameter (peak-peak, rms period, frequency).
6. Soldering practice using general purpose PCB

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

Semester 2

Pre-Requisites : None

Objectives:

To make the students to

- know the importance of listening skill for effective communication
- practice conversation and public speaking in English
- prepare for competitive examinations
- comprehend the format of business communication
- gain knowledge on communication abilities and language skills

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1 : communicate effectively

CO2 : do public speaking

CO3 : take up competitive examinations

CO4 : communicate officially

CO5 : master the language

Unit I INTRODUCTION TO COMMUNICATIVE ENGLISH 9

Listening: Listening to longer texts and filling up the table. Speaking: Describing a product. Reading: Reading Biography/ Autobiography of Scientists/ eminent personalities and answering the questions. Writing: simple, Compound and Complex sentences, One word Substitutes, Essay Writing

Unit II ENGLISH FOR COMPETITIVE EXAMS 9

Listening: listening to personal information. Speaking: Sharing personal information (likes and dislikes), Reading: Reading scientific blogs- projects related to engineering. Writing: Sample questions from International English Language Testing System (IELTS), Test of English as foreign language (TOEFL) & Civil Service (Language related)

Unit III FORMAL COMMUNICATION 9

Listening: Listening to formal conversation, Speaking: Role- play. Reading: Cloze Reading. Writing: Preposition, Phrasal Verbs, Singular or Plural Words, Degrees of Comparison, Job Application- Cover letter and Resume, Writing Circulars

Unit IV VERBAL AND NON- VERBAL COMMUNICATION 9

Listening: Listening to Mock Group Discussion and evaluating. Speaking: Making Presentation on the given topic. Reading: Interpreting pictures and graphs- pie chart, flow chart, bar diagram and line graph. Writing: Infinitives and Gerunds, Regular and Irregular Verbs, Indefinite and Definite Articles

Unit V LANGUAGE SKILLS 9

Listening to Interviews. Speaking: Discussing company information/ describing the given data, trends and sales, Problem Solving techniques, Reading: Reading essays on global warming and other prevailing social issues. Writing: Contractions, Conjunctions or 'Joining Words, Subject -Verb Agreement, Proposal writing, Poster making

Total Periods: 45

List of Experiments:

1. Listening to longer texts and filling up the table.
2. Speaking: Describing a product.
3. Listening to personal information.
4. Speaking: Sharing personal information (likes and dislikes),
5. Listening to formal conversation,
6. Speaking: Role- play.

- Text Books:**

Reference Books:

Web URL(s):

- | COs | POs | | | | | | | | | | | | PSOs | |
|---|-----|---|---|---|---|---|---|---|---|----|----|----|------|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 |
| CO1 | 3 | 1 | 2 | | 2 | | | | | 3 | | 2 | | |
| CO2 | 3 | 1 | 2 | | 2 | | | | | 3 | | 2 | | |
| CO3 | 3 | 1 | 2 | | 2 | | | | | 3 | | 2 | | |
| CO4 | 3 | 1 | 2 | | 2 | | | | | 3 | | 2 | | |
| CO5 | 3 | 1 | 2 | | 2 | | | | | 3 | | 2 | | |
| <div> <div>1 - Reasonably agreed</div> <div>2 - Moderately agreed</div> <div>3 - Strongly agreed</div> </div> | | | | | | | | | | | | | | |

U19MAT02	ENGINEERING MATHEMATICS - II	L	T	P	C
	(Common to All Branches)	3	1	0	4

Pre-Requisites : Concepts of Differentiation and Integration

Objectives:

- Understand the concepts of gradient, divergence and curl through vector differentiation.
- Distinguish line integral, double integral, triple integral using vector integration.
- Interpret the solution of second order differential equation.
- Exemplify the concept of Laplace transforms that converts time domain to frequency domain.
- Represent the concept of inverse Laplace transform for engineering problems.

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1 : Compute gradient, curl and divergence using vector differentiation.

CO2 : Evaluate line integral, double integral and volume integral using vector integration.

CO3 : Analyze and model the real time problems using differential equations.

CO4 : Apply the knowledge of Laplace transforms for periodic functions.

CO5 : Analyze and model the differential equations using Laplace transform.

Unit I VECTOR DIFFERENTIATION 9+3

Vector of scalar fields, directional derivative, gradient of a scalar field, surfaces, scalar potential, divergence and curl-Line integrals and independent of path, conservative vector fields-work done by a force.

Unit II VECTOR INTEGRATION 9+3

Double integrals, surface integral-flux, Green's theorem, triple integral- Gauss divergence theorem-Stoke's theorem

Unit III LINEAR DIFFERENTIAL EQUATION OF SECOND ORDER 9+3

Linear equations of second order with constant and variable coefficients (Euler,Cauchy's and Legendre's), Method of variation of parameter-Applications:electric circuit.

Unit IV LAPLACE TRANSFORM 9+3

Laplace transform: Linearity, shifting, transform of derivatives and integrals, Periodic function.

Unit V INVERSE LAPLACE TRANSFORM 9+3

Inverse linear transform: Convolution theorem(Statement only) ,partial fraction ,unit step and impulse function, Initial and Final value theorem,(Statements) Applications: differential equations .

Total Periods 45+15

Text Books:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	B.S.Grewal	Higher Engineering Mathematics,	Khanna Publishers, 43rd Edition,Delhi	2015
2.	E.Kreyszig	Advanced Engineering Mathematics	John Wiley and Sons(Asia)Ltd Tenth Edition ,Singapore	2015

Reference Books:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Glyn James	Advanced Modern Engineering Mathematics	Wiley India	2014
2.	Samantha Pal, Subodha .C.Bhunia	Engineering Mathematics	Oxford University	2015
3.	C.Ray.Wylie, Loui's C.Barrett	Advanced Engineering Mathematics,	6 th edition,McGrawhill, New Delhi	2014

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

U19PYE02	APPLIED PHYSICS	L	T	P	C
	(Common to CIVIL, MECH and MCT)	3	0	2	4

Pre-Requisites : None

Objectives:

To make the students

- know about the elastic properties of materials.
- understand the different aspects of sound and production of ultrasonic.
- comprehensive knowledge about diodes and identify its terminals.
- learn to apply the lever rule to determine the percentage of Phase present in ferrous alloys .
- understand the concept of ceramics, composites, metallic glasses and shape memory alloys.

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1 : apply the elastic properties of materials in engineering design.

CO2 : analyze the aspect of sound in audio and noise control industries.

CO3 : explain the types of semiconductors and its applications in electronic devices.

CO4 : apply the principle of iron carbon diagram to determine the phases in ferrous alloy materials in steel industries.

CO5 : select appropriate materials for latest automotive and aerospace industries.

Unit I Properties of Matter 9

Elasticity – Stress-strain relationship - factors affecting elastic modulus and tensile strength – twisting couple - torsion pendulum: theory and experiment - bending of beams - bending moment – cantilever: theory and experiment – uniform and non-uniform bending: theory and experiment - Mechanical properties of Engineering materials - Tensile strength, Hardness, Fatigue.

Unit II Acoustics and Ultrasonics 9

Classification of sound- decibel- Weber–Fechner law – Sabine’s formula (No derivation) - Absorption Coefficient and its determination –factors affecting acoustics of buildings (Optimum reverberation time, loudness, focusing, echo, echelon effect, resonance and noise) and their remedies.

Ultrasonics – Principle- - Production of ultrasonics by Magnetostriction and piezoelectric methods-Non Destructive testing – pulse echo system through transmission and reflection modes.

Unit III Semi Conducting Materials 9

Elemental and compound semiconductors - intrinsic semiconductors: carrier concentration – electrical conductivity-band gap. Extrinsic semiconductors: carrier concentration - variation of Fermi level. Hall effect: theory and experimental determination -applications of Hall effect, Light emitting diode, Photo diode.

Unit IV Phase Diagrams and Ferrous Alloys 9

Solid solutions – Hume Rothery's rules – the phase rule – single component system – one component system of iron – binary phase diagrams – isomorphous systems – the tie-line rule – the lever rule – isomorphous system – eutectic phase diagram – free energy composition curve for binary systems – microstructural change during cooling. The iron – carbon equilibrium diagram phases, invariant reactions – eutectoid steel, hypo and hypereutectoid steels.

Unit V Advanced Materials 9

Ceramics – types and applications – Composites – classification, role of matrix and reinforcement, processing of fiber reinforced plastics - Metallic glasses: types , glass forming ability of alloys, melt spinning process, applications -shape memory alloys: phases, shape memory effect, pseudoelastic effect, NiTi alloy, applications .

Total Periods 45

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 Young's modulus by uniform bending method.
3. Determination of thickness of a thin wire by Air wedge method.
4. Determination of thermal conductivity of a bad conductor–Lee's Disc method.
5. Determination of wavelength of mercury spectrum–spectrometer grating.
6. Determination of band gap of a semiconductor.

Text Books:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Brijlal, N.Subrahmanayam	Properties of Matter	S.Chand & Company Ltd., New Delhi.	2001
2.	William D. Callister.Jr	Materials Science and Engineering, 9 th edition	John Wiley and sons,Inc,	2014

Reference Books:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Rajendran.V	Engineering Physics	Tata McGraw Hill Education private limited, New Delhi.	2012
2.	Lawrence E.Kinsler, Austin R.Frey, Alan B.Coppens, James V.Sanders	Fundamentals of Acoustics, Fourth edition	Jonwiley and sons inc.UK.	2010
3.	Dr.G.Senthil Kumar	Materials science, Revised edition	VRB Publications, Chennai.	2018

COs	POs												PSOs	
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CO1	2	3	2	1	-	-	-	-	-	-	-	-		
CO2	1	1	1	-	-	-	-	-	-	-	-	-		
CO3	2	2	2	2	-	1	-	-	-	-	-	-		
CO4	3	2	2	1	-	-	-	-	-	-	-	1		
CO5	2	3	2	2	-	1	-	-	-	-	-	-		
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

U19MET03

Engineering Mechanics
(Common to MECH, MCT and CIVIL)

L	T	P	C
3	1	0	4

Pre-Requisites : Nil

Objectives:

- To apply the laws of Mechanics to solve basic problems in day to day life.
- To develop capacity to predict the effect of force and motion in the course of carrying out the design functions of engineering.
- To develop the ability to understand the properties of surfaces and solids
- To apply the laws of friction to solve the simple life problems
- To develop the ability, in the engineering student, to understand the laws of motion and dynamic force

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Analyze the effect of forces, its magnitudes and direction

CO2 : Analyze the rigid body in equilibrium

CO3 : Evaluate the properties of surfaces and solids

CO4 : Determine the frictional resistance and the effects by the laws of friction

CO5 : Calculate dynamic forces exerted on rigid body

Unit I Statics of Particles 9

Introduction to Mechanics – Fundamental Principles – Laws of Mechanics, Lame's theorem, Parallelogram and triangular Law of forces, Coplanar forces – Resolution of forces –Equilibrium of particle in space

Unit II Statics of Rigid Bodies 9

Free body diagram – Types of supports and their reactions – Moments and Couples – Moment of a force about a point and about an axis – Varignon's theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions

Unit III Properties of Sections 9

Centroid - Rectangular, circular, triangular areas – T section, I section, Angle section, – Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, – Parallel axis theorem and perpendicular axis theorem –Principal moments of inertia of plane areas – Product of inertia and Mass moment of inertia of Cylinder, Cone and combination.

Unit IV Dynamics of Particles and Friction 9

Displacements, Velocity and acceleration, their relationship – relative motion – Curvilinear motion - Projectiles– Newton's law of motion – Work Energy Equation of particles – Impulse and Momentum – Impact of elastic bodies- Impact - direct and central impact – coefficient of restitution.

Friction - Characteristics and Laws of Dry friction - Problems involving dry and ladder friction

Unit V Dynamics of Rigid Bodies 9

General plane motion –Velocity and Acceleration- Absolute and Relative motion method - Equilibrium of rigid bodies in plane motion- D'Alembert's Principle- Work Energy Principle-Principle of impulse momentum for rigid bodies in plane motion

Total Periods 45

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Vela Murali	Engineering Mechanics	Oxford University Press	2010
2.	Ferdinand P. Beer, E. Russell Johnston.	Vector Mechanics for Engineers: Statics and Dynamics (9 th Edition)	Tata McGraw-Hill International Edition	2010

Reference Books:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	J. L. Meriam and L. G. Kraige	Engineering Mechanics: Statics and Dynamics (6 th Edition)	Wiley Publishers	2006
2.	Rajasekaran S and Sankarasubramanian G.	Engineering Mechanics Statics and Dynamics”, 3rd Edition	Vikas Publishing House Pvt. Ltd.	2005
3.	Kumar, K.L.,	Engineering Mechanics, 3rd Revised Edition,	Tata McGraw-Hill Publishing company, New Delhi.	2008

Bloom's Taxonomy Level

K1- Remember (Re), K2 – understand (Un), K3- Apply (Ap), K4- Analyse (An),

K5- Evaluate (Ev), K6 – Create (Cr)

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

U19CSE01	Problem Solving and Python Programming	L	T	P	C
	(Common to CSE, IT, ECE, EEE)	3	0	2	4

Pre-Requisites : None

Objectives:

- To know the basics of algorithmic problem solving
- To read and write simple Python programs.
- To develop Python programs with conditionals and loops.
- To define Python functions and call them.
- To use Python data structures – lists, tuples, dictionaries.
- To do input/output with files in Python

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1 : Develop algorithmic solutions to simple computational problems

CO2 : Read, write, execute by hand simple Python programs.

CO3 : Structure simple Python programs for solving problems.

CO4 : Decompose a Python program into functions.

CO5 : Represent compound data using Python lists, tuples, and dictionaries.

Unit I Problem Solving Techniques 9

General problem Solving concepts:- Algorithm, Pseudo-code and Flowchart Problem Solving with Sequential Logic Structure - Problem Solving with Decisions - Problem Solving with Loops. **Case Study:** Raptor and Scratch Tools.

Unit II Basics of Python Programming 8

Features of Python, History of Python, The Future of Python, Literal Constants, Variables and Identifiers, Data Types, Input Operation, Comments, Reserved Words, Indentation, Operators and Expressions, Expressions in Python, Operations on Strings, Other Data Types, Type Conversion, String-String functions and methods

Unit III Decision Control Statements 9

Introduction to Decision Control, Selection/Conditional Branching Statements, Basic Loop Structures/ Iterative Statements, Nested Loops, The break Statement, The continue Statement, The pass Statement, The else Statement used with Loops. Case Study: Simple Calculator, Generating a Calendar

Unit IV Lists, Tuples, Dictionaries 10

Sequence, Lists- Access Values in Lists, Updating Values in Lists, Nested Lists, Cloning Lists, Basic List Operations, List Methods, Looping in Lists, Tuple- Creating Tuple, Accessing Values in a Tuple, Basic Tuple Operations, Tuple Assignment, Sets, dictionaries- Creating a Dictionary, Accessing Values, Adding and Modifying an Item in a Dictionary, Modifying an Entry, Deleting Items, Sorting Items in a Dictionary, Looping over a Dictionary, Nested Dictionaries

Unit V Functions, Modules and Packages 9

Introduction, Function Definition, Function Call, Variable Scope and Lifetime, The return statement, Recursive Functions, Modules, Packages in Python, Standard Library modules. Case Study: Tower of Hanoi, Shuffling a Deck of Cards

Total Periods: 45

List of Experiments:

1. Draw Flowchart using Raptor Tool
 - a. Simple Flow Chart
 - b. Decision Making
 - c. Looping[Pre test & Post test]
2. Create Animation / Gaming /Application using Scratch Tool
3. Programs on Operators and expressions.
4. Program using Decision Making Statement

5. Programs using Looping Statements
6. Programs on List (Searching , Sorting)
7. Programs on Tuple
8. Program on Dictionaries
9. Programs using Strings Operations
10. Program using Functions
11. Programs using Modules and Packages

Text Books:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	M. Sprankle	Problem Solving and Programming Concepts	Pearson Education	2011
2.	Reema Thareja	Python Programming using problem solving	Oxford University	2017

Reference Books:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Allen B. Downey	Think Python	O'Reilly Media	2012
2.	Mark Lutz.	Learning Python	O'Reilly Media	2013
3.	Alex	Python in a Nutshell	O'Reilly Media	2006

Web URL(s):

1. <https://docs.python.org/3/tutorial/>
2. <https://www.tutorialspoint.com/python/>
3. <https://nptel.ac.in/courses/106106182/>
4. https://scipy-lectures.org/intro/language/python_language.html

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

U19MEP01

COMPUTER AIDED DRAFTING LABORATORY
(Common to MECH, MCT and CIVIL)

L	T	P	C
0	0	4	2

Pre-Requisites : Nil

Objectives:

- To draw simple figures with title block using CAD software commands.
- To sketch curves like parabola, spiral and involute of square & circle and draw the orthographic projection of simple solids.
- To prepare orthographic projection of simple machine parts and draw a plan of residential building
- To develop skill in sketching simple steel truss and sectional views of simple solids.
- To develop skill to use software to create 2D and 3D models.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1:** Sketch simple figures with title block using CAD software commands.
- CO2 :** Sketch curves like parabola, spiral and involute of square & circle and draw the orthographic projection of simple solids.
- CO3 :** Prepare orthographic projection of simple machine parts and draw a plan of residential building
- CO4 :** Sketch simple steel truss and sectional views of simple solids.
- CO5 :** Prepare 2D multi view drawing from 3D model

List of Experiments:

1. Study of capabilities of software for Drafting and Modeling – Coordinate systems (absolute, relative, polar, etc.) – Creation of simple figures like polygon and general multi-line figures.
2. Drawing of a Title Block with necessary text and projection symbol.
3. Drawing of curves like parabola, spiral, involute using Bspline or cubic spline.
4. Drawing of front view and top view of simple solids like prism, pyramid, cylinder, cone, etc, and dimensioning.
5. Drawing sectional views of prism, pyramid, cylinder, cone, etc,
6. Drawing front view, top view and side view of objects from the given pictorial views (eg. V- block, Base of a mixie, Simple stool, Objects with hole and curves).
7. Drawing isometric projection of simple objects.
8. Creation of 3-D models of simple objects and obtaining 2-D multi-view drawings from 3-D model.
9. Drawing of a plan of residential building (Two bed rooms, kitchen, hall, etc.)
10. Drawing of a simple steel truss.

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

Semester 3

U19MAT04	TRANSFORMS AND BOUNDARY VALUE PROBLEMS	L	T	P	C
	(Common to CIVIL,ECE,EEE,MECH,MCT)	3	1	0	4

Pre-Requisites : Types of integration and differentiation

Objectives:

To make the students to

- Interpret the effective mathematical tools to solve several physical problems by applying the solutions of partial differential equations .
- Demonstrate the methodologies involved in solving many applications in engineering apart from its use in solving boundary value problems
- Exemplify the concepts of Fourier transform.
- Improve the ability in solving applications of partial differential equations.
- Understand the concepts of Z transform techniques for discrete time systems and to solve the difference equations.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Determine types of partial differential equations and to solve it.
2. Explore the geometrical applications of Fourier series.
3. Apply the knowledge of Fourier transform to compute the solution.
4. Explore the basic concepts and solve partial differential equations for application in their field of engineering.
5. Be exposed to the concepts to solve Z transform for application in the field of engineering.

Unit I PARTIAL DIFFERENTIAL EQUATION 12(9+3)

Formation of Partial Differential equation by elimination arbitrary constants and arbitrary functions, Solution of standard types of first order equations, Lagrange's equation, linear partial Differential equation of second and higher order with constant coefficients.

Unit II FOURIER SERIES 12(9+3)

Dirichlet's conditions, General Fourier series, Half Range Sine and Cosine series, Parseval's identity, Harmonic Analysis.

Unit III FOURIER TRANSFORM 12(9+3)

The infinite Fourier transform , sine and cosine transform, properties, inversion theorem, Parseval's identity and convolution theorem (statement only)

Unit IV BOUNDARY VALUE PROBLEMS 12(9+3)

Classification of Second order linear partial differential equations, solutions of one-dimensional wave equation, one-dimensional heat equation ,steady state solution of two dimensional heat equation, Fourier series solution in cartesian coordinates

Unit V Z – TRANSFORMS 12(9+3)

Definition and properties, Elementary Problems, convolution theorem (statement only), Inverse Z transforms (partial fraction method and residue method), Application of Z – Transforms in solving difference equations.

Total Period 60(45+15)

Text/Reference Books:

1. B.S.Grewal (2001). Higher Engineering Mathematics. 42th Edition. Khanna Publishers,Delhi.
2. Srimanta Pal & Subhodh C.Bhunia,"Engineering Mathematics",9th edition ,John Wiley & Sons,2012
3. Bali.N. P and Manish Goyal, "A Textbook of Engineering Mathematics", 7th Edition, Laxmi Publications Pvt Ltd, 2007.
4. E.Kreyszig (2001). Advanced Engineering Mathematics. Tenth Edition. John Wiley and Sons (Asia)Ltd, Singapore.
5. Dennis.G.Zill & Michael .R.Cullen,"Advanced Engineering Mathematics,2nd edition, CBS publishers,2012.

Bloom's Taxonomy Level

K1- Remember (Re), K2 – understand (Un), K3- Apply (Ap), K4- Analyse (An),

K5- Evaluate (Ev), K6 – Create (Cr)

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

Pre-Requisites : None

Objectives:

- To learn about different methods of manufacturing applied in mechanical oriented industries.
- To understand the manufacturing processes in correlation with material properties which change the shape, size and form of the raw materials into the desirable product by conventional
- To explore the different machining processes by unconventional methods
- To learn state of the art manufacturing methods.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Learn the basics of casting and joining technologies, inspection procedures and its relevant codes.
- CO2 :** Understand the plastic deformation processes, load calculation of various deformation processes
- CO3 :** Know the conventional machining processes and its removal mechanism
- CO4 :** Select the appropriate unconventional machining process for specific industrial applications
- CO5 :** Analyze the role of various Additive Manufacturing processes according to industries requirements

Unit I METAL CASTING AND JOINING PROCESSES 9

Concepts of Manufacturing Process -Sand casting -Patterns – Moulding sand– Moulding machines-Core making- Testing- Furnaces – Casting Defects and Inspections; Physics of Welding-various Welding processes-Soldering-Brazing-Plastic welding, Welding defects-NDT Certification -Welding Codes; Adhesive Bonding-semi solid and liquid for Metals and Polymers

Unit II DEFORMATION PROCESSES AND SHEET METAL FORMING 9

Plastic deformation-Yield criteria; Fundamentals of Hot and Cold working processes –Forging-Rolling- Extrusion-Drawing, Load calculations; Formability of Sheet Metal, Shearing, Deep drawing, Bending operations-Super Plastic forming; Introduction to Powder Metallurgy

Unit III CONVENTIONAL MACHINING PROCESSES 9

Orthogonal cutting, Oblique cutting, Chip formation, Mechanism of removal, Merchant and Lee Shaffer Theories, Machinability, Cutting Tools: Single, Multi-Point, Tool Signature, Inserts, Wear, Life, Materials, cutting fluids; Conventional Machining -Turning, Drilling, Milling and finishing processes, Introduction to CNC machining

Unit IV UNCONVENTIONAL MACHINING PROCESSES 9

Abrasive Jet Machining (AJM), Water Jet Machining (WJM), Ultrasonic Machining (UM), Electrochemical Machining (ECM). Electric Discharge Machining (EDM), Laser Beam Machining (LBM), Plasma Arc Machining (PAM), Electron Beam Machining (EBM) - principles, power sources, process parameters, MRR, Surface finish, process capabilities and tooling.

Unit V ADDITIVE MANUFACTURING 9

Fundamentals of Additive Manufacturing (AM)-Product Development-Materials for AM- Stereolithography apparatus - STL file - Fused Deposition Modeling- Laminated Object Manufacturing- Selective Laser sintering- 3D Printer – Tooling.

Total Periods 45

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Rao P.N.	Manufacturing Technology: Foundry, Forming and Welding	Tata McGraw Hill 3rd Edition	2009
2.	Sharma P.C	A Text book of Production Technology	S. Chand and Co. Ltd	2009
3.	Chua C.K., Leong K.F., and Lim C.S	Rapid Prototyping: Principles and Applications	Third Edition, World Scientific Publishers	2010

S.No	Authir(s)	Title of the Book	Publisher	Year of Publication
1.	Mikell P. Groover	Fundamentals of Modern Manufacturing: Materials, Processes, and System	John Wiley and Sons Inc	2010
2.	Steven R. Schmid and Serope Kalpakjian	Manufacturing processes for Engineering Materials	5th Edition, Pearson Education India	2009
3.	Adithan M. and Gupta A.B.	Manufacturing Technology	New Age International Pvt Ltd	2003

1. <https://nptel.ac.in/courses/112107144>

K1- Remember (Re), K2 – understand (Un), K3- Apply (Ap), K4- Analyse (An), K5- Evaluate (Ev), K6 – Create (Cr)

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

Pre-Requisites : Knowledge of Engineering Physics

Note : Use of Standard and approved Steam Table, Mollier Chart, Compressibility Chart and Psychrometric Chart is permitted

Objectives:

- To familiarize the students to understand the fundamentals of thermodynamics
- To perform thermal analysis on their behavior and performance.
- To achieve an understanding of principles of thermodynamics and to be able to use it in accounting for the bulk behaviour of the simple physical systems.
- To enlighten the basic concepts of vapour power cycles
- To understand the working of Air standard cycles

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 Apply the Thermodynamic Principles to Mechanical Engineering Application.

CO2 Apply the first law of thermodynamics for simple open and closed systems under steady and unsteady conditions

CO3 Apply Rankine cycle to steam power plant and compare few cycle improvement methods

CO4 Derive simple thermodynamic relations of ideal and real gases

CO5 Calculate the properties of gas mixtures and moist air and its use in psychometric processes

Unit I BASIC CONCEPTS AND FIRST LAW

10+3

Basic concepts - comparison of microscopic and macroscopic approach. Intensive and extensive, 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, First law of thermodynamics –application to closed and open systems – steady flow processes.

Unit II SECOND LAW AND ENTROPY

10 +3

Zeroth law of thermodynamics – concept of temperature and thermal equilibrium. Heat Reservoir, source and sink. Heat Engine, Refrigerator and Heat pump. Statements of second law and its corollaries. Carnot cycle, Reversed Carnot cycle, Performance. Clausius inequality. Concept of entropy, T-s diagram, entropy change for - pure substance, principle of increase in entropy

Unit III IDEAL AND REAL GASES, THERMODYNAMIC RELATIONS

9 + 3

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.-Generalised Compressibility Chart and its use-Maxwell relations, Tds Equations, Difference and ratio of heat capacities, Energy equation, Joule-Thomson Coefficient, Clausius Clapeyron equation, simple calculations

Unit IV STEAM AND VAPOUR POWER CYCLE

9 + 3

Formation of steam and its thermodynamic properties, T-s, h-s diagrams. Use of Steam Table and Mollier Chart. Determination of dryness fraction. Ideal and actual Rankine cycles, Cycle Improvement Methods - Reheat and Regenerative cycles

Unit V AIR STANDARD CYCLES

7 + 3

Internal combustion (IC) engine - Components and their functions – Working of IC Engine, Otto, Diesel, Dual and Brayton cycles, Calculation of mean effective pressure, and air standard efficiency - Comparison of cycles

Total Periods

60

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Yunus A Cengel , Michael A Boles	Thermodynamics	Tata McGraw – Hill Publishing Company Limited	2014
2.	Natarajan E	Engineering Thermodynamics: Fundamentals and Applications	Anuragam Publications	2012

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Nag P.K	Engineering Thermodynamics	Tata McGraw – Hill Publishing Company Limited	2013
2.	Holman J P	Thermodynamics	McGraw – Hill Publishing Company Limited	1995
3.	Arora C.P	Thermodynamics	Tata McGraw – Hill Publishing Company Limited	2003
4.	Ganesan V	Internal Combustion Engines	Tata McGraw – Hill Publishing Company Limited	2007

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Kothandaraman C.P	Steam Tables, 4th Edition	New Age International	2015

1. <https://nptel.ac.in/courses/112105123/>
2. <http://www.nptel.ac.in/downloads/112108148/>
3. <http://www.freebookcentre.net/Physics/ThermoDynamics-Books.html>

K1- Remember (Re), K2 – understand (Un), K3- Apply (Ap), K4- Analyse (An), K5- Evaluate (Ev), K6 – Create (Cr)

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

U19MEE01	Strength of Materials	L	T	P	C
		2	1	2	4

Pre-Requisites : Knowledge of Engineering Mechanics

Objectives:

- To study and estimate the mechanical properties of materials including its deformations under different loading conditions through experiments.
- To learn two dimensional stress systems and stresses in thin cylinders and spherical shells.
- To understand the deformation of shaft under torsion and deflection of closed helical springs.
- To gain knowledge on shear force and bending stress distribution in different beams under various loads.
- To impart knowledge on finding slope and deflection of beams and buckling of columns for various boundary conditions.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Evaluate the stresses and strains in a regular and composite structures subjected to axial loads.
- CO2 :** Examine the stresses in two dimensional systems, thin cylinders and spheres.
- CO3 :** Examine the stresses induced in shaft and closed coil helical springs subjected to torsion.
- CO4 :** Examine the shear force, bending moment and shear stress of various beams under different loading conditions
- CO5 :** Evaluate the slope and deflection of beams and buckling loads of columns with different boundary conditions.

Unit I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Introduction to mechanical properties - stresses and strains due to axial force, shear force, impact force and thermal stresses - stepped and composite bars - uniformly varying cross section. Stress-strain curve for ductile and brittle materials-Hooke law-Factor of safety –Poisson ratio - Elastic constants and their relationship.

Unit II ANALYSIS OF STRESSES, THIN CYLINDERS AND SPHERES 9

State of stresses at a point-Normal and shear stresses on inclined planes-Principal planes and stresses- Plane of maximum shear stress-Mohr's circle for bi-axial stress with shear stress - Hoop and longitudinal stresses in thin cylindrical and spherical shells-Changes in dimensions and volume.

Unit III TORSION IN SHAFT AND HELICAL SPRING 9

Analysis of torsion of circular solid and hollow shafts-stepped shaft-compound shaft- angle of twist and torsional stiffness. Closed coil helical spring-stresses and deflection under axial load-Maximum shear stress in spring section including Wahl's Factor - applications.

Unit IV LOADS AND STRESSES IN BEAMS 9

Types of beams-Supports and Loads, Shear force and Bending Moment in beams, Cantilever, simply supported and overhanging beams-Point of contra flexure. Theory of simple bending - bending and shear stress - stress variation along the length and section of the beam,

Unit V DEFLECTION OF BEAMS AND COLUMNS 9

Slope and Deflection of cantilever, simply supported and overhanging beams- Double integration method and Macaulay's method. Columns-types-Equivalent length- Euler and Rankine formulae - Slenderness

Total Periods 45

LIST OF EXPERIMENTS:

1. Find the hardness of the material using Rockwell hardness tester.
2. Calculate the hardness of the material using Brinell hardness tester.
3. Calculate the hardness of the material using Vickers hardness tester.
4. Experimental study of an axial bar under tension to obtain the stress strain curve and the strength.
5. Determine the Young-modulus and stiffness of a metal beam through load deflection curve.
6. Experimentally calculate the compressive strength of the materials.
7. Experimental analysis of a bar under torsion to obtain stiffness and angle of twist.
8. Determination of spring constant through load vs deflection curve.
9. Experimentally calculate the strain energy of a material subjected to impact loading

Text Books:

S.No	Authir(s)	Title of the Book	Publisher	Year of Publication
1.	Bansal, R.K.,	Strength of Materials	Laxmi Publications (P) Ltd New Delhi	2007.
2.	Jindal U.C.,	Strength of Materials	Asian Books Pvt. Ltd., New Delhi	2007

Reference Books:

S.No	Authir(s)	Title of the Book	Publisher	Year of Publication
1.	S.S.Rattan	Strength of Materials Second Edition	Tata McGraw Hill, Delhi	2011.
2.	F. P. Beer and R. Johnston	Mechanics of Materials Third edition	Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi,	2002
3.	Egor P. Popov	Engineering Mechanics of Solids	Prentice Hall of India Learning Pvt. Ltd, New Delhi,	2010

Web URL(s):

1. <https://nptel.ac.in/courses/112107146/>
2. https://swayam.gov.in/nd1_noc19_ce18/

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

Pre-Requisites : Knowledge of Engineering Mechanics

Objectives:

- To understand the basic principles involved in fluid mechanics and machinery..
- To learn the behavior of fluid particles under rest and moving conditions.
- To understand the moment principle in fluid mechanics and its application in flow through pumps as well as turbines.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Identify the importance of fluids properties and fluid principles at rest.
- CO2 :** Know the physical behavior of fluids system and equations under moving conditions.
- CO3 :** To apply the concept of dimensional analysis for model study.
- CO4 :** To conduct the performance test on different types of turbines
- CO5 :** To conduct the performance study and selection of pumps for different applications.

Unit I FLUID PROPERTIES

9

Units and Dimensions – Fluid properties – Density, Specific gravity, Viscosity, Surface tension, Capillarity, Compressibility and Bulk modulus – Pascal’s Law – pressure measurements – manometers - Fluid statics - Total pressure and centre of pressure on submerged surfaces

Unit II FLUID KINEMATICS AND DYNAMICS

9

Types of fluid flow and flow lines – control volume – continuity equation in one-dimension and three dimension – velocity potential and stream function -Energy equation – Euler and Bernoulli’s equations – Applications of energy equations- Flow meters - Laminar and Turbulent flow through pipes – Hagen Poissuille equation- Darcy Weisbach formula- applications

Unit III DIMENSIONAL ANALYSIS

9

Need for dimensional analysis – Dimensional Homogeneity – Rayleigh’s and Buckingham methods of dimensional analysis –Problems. Model study and Similitude – scale effects and distorted model.

Unit IV HYDRAULIC TURBINES

9

Classification – construction, working principles and design of Pelton wheel, Francis and Kaplan Turbines - head, losses, work done and efficiency - specific speed – operating characteristics - Governing of Turbines – Problems.

Unit V PUMPS

9

Classification of pumps - Centrifugal pump - working principle - discharge, work done and efficiencies – Gear oil and Multistage pumps - Reciprocating pumps - work done and efficiencies -Problems.

Total Periods 45

LIST OF EXPERIMENTS:

1. Determination of the Coefficient of discharge of given Orifice meter.
2. Determination of the Coefficient of discharge of given Venturi meter.
3. Calculation of the rate of flow using Rota meter.
4. Determination of friction factor for a given set of pipes.
5. Conducting experiments and drawing the characteristic curves of centrifugal pump/ submergible pump
6. Conducting experiments and drawing the characteristic curves of reciprocating pump.
7. Conducting experiments and drawing the characteristic curves of Gear pump.
8. Conducting experiments and drawing the characteristic curves of Pelton wheel.
9. Conducting experiments and drawing the characteristics curves of Francis turbine.
10. Conducting experiments and drawing the characteristic curves of Kaplan turbine.

Text Books:

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Rajput.R.K	A text Book of Fluid Mechanics and Machinery	S. Chand and Company New Delhi	2009
2.	Modi.P.N. and Seth.S.M.,	Hydraulics and Fluid Mechanics including Hydraulic Machines	Standard book house, Delhi	2015
3.	Bansal R K	Fluid Mechanics and Hydraulic Machines	Laxmi Publications New Delhi	2015

Reference Books:

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Streeter, Victor L . and Wylie, E. Benjamin	Fluid Mechanics	Tata McGraw Hill, Delhi	2017
2.	Natarajan.M.K	Fluid Machines	Anuradha Agencies, Vidayal Karuppur, Kumbakonaam	1998
3.	Kumar.K.L	Engineering Fluid Mechanics	Eurasia Publishing House (P) Ltd., New Delhi	2008

Web URL(s):

1. <https://nptel.ac.in/courses/112105206/>

Bloom's Taxonomy Level

K1- Remember (Re), K2 – understand (Un), K3- Apply (Ap), K4- Analyse (An),

K5- Evaluate (Ev), K6 – Create (Cr)

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

Pre-Requisites : Knowledge of Engineering Graphics

Objectives:

- To use limits, fits and tolerances in real world problems.
- To apply different sectional views in drawings .
- To recognize the drawing notations of standard machine elements.
- To familiarize the students with Indian Standards on drawing practices and standard components.
- To draw the detailed drawing of given components.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Examine limits, fits and tolerances in real world problems
- CO2 :** Sketch the sectional views of simple elements.
- CO3 :** Select and draw the standard mechanical elements like bolt, nut, screw, etc
- CO4 :** Draw the assembly drawing of automobile components
- CO5 :** Draw the detailed drawing of automobile components.

Unit I LIMITS, FITS AND TOLERANCES 6

Limit System- Tolerance, Limits, Deviation, Actual Deviation, Upper Deviation, Lower Deviation, Allowance, Basic Size, Design Size, Actual Size. Fits- Types, Tolerances of Form and Position- Form and Position Variation, Geometrical Tolerance, Tolerance Zone, Indicating Geometrical Tolerances. Indication of Surface Roughness, Standard Abbreviations and Symbols used in industries

Unit II SECTIONAL VIEWS 12

Sections- Hatching of Sections, Cutting Planes, Revolved or Removed Section, Sectional Views- Full Section, Half Sections and Auxiliary Sections- Conventional Representation-One view, Two view and Three view Drawings.

Unit III DRAWING OF BASIC MACHINE ELEMENTS 12

Drawing standards and Designation of Bolts, nuts, screws, keys, pins, Rivets, Welded Joints - Dimensioning of Welds, Belt Driven Pulleys, Chain and Gears Drives.

Unit IV ASSEMBLY DRAWINGS 15

Preparation of manual parts drawing and assembled sectional views from orthographic part drawings, Automobile components - stuffing box, Machine Tool Parts - plummer block - knuckle joints - Protected type flanged coupling, - universal coupling - swivel bearing - Preparation of Bill of materials and tolerance data sheet.

Unit V DETAILED MACHINE DRAWINGS 15

Preparation of assembled sectional views from real time products- Internal combustion engine parts - connecting rod, piston - machine tool parts - tailstock, Automobile components - screw jack - stuffing box - Preparation of Bill of materials and tolerance data sheet.

Total Periods 60

Text/Reference Books:

S.No	Authir(s)	Title of the Book	Publisher	Year of Publication
1.	N.D. Bhatt	Machine Drawing	Charotar Publishing House Pvt. Ltd, New Delhi	2014.
2.	Gopalakrishna K R,	Machine Drawing	Subhas Stores, Bangalore	2003

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

Semester 4

U19MAT08	STATISTICS AND NUMERICAL METHODS	L	T	P	C
	(Common to MECH & MCT)	3	1	0	4

Pre-Requisites : Concepts of integration, differentiation and basic of probability and standard distributions

Objectives:

To provide the necessary basic concepts and procedures for solving numerically, different kinds of problems occurring in engineering and technology.

- The roots of nonlinear equations, solutions of large system and problem of matrix can be obtained numerically where analytical methods fail to give solution
- When huge amounts of experimental data are involved, the methods discussed on interpolation will be useful in constructing approximate polynomial to represent the data and to find the intermediate values.
- The numerical differentiation and integration find application when the function in the analytical form is too complicated or the huge amounts of data are given such as series of measurements, observations or some other empirical information.
- Since many physical laws are couched in terms of rate of change of one /two or more independent variables, most of the engineering problems are characterized in the form of either nonlinear ordinary differential equations or partial differential equations. The methods introduced in the solution of ordinary differential equations will be useful in attempting any engineering problems.
- It helps the students to have a clear perception of the power of statistical and numerical techniques, ideas and would be able to demonstrate the applications of these techniques to problems drawn from industry, management and other engineering fields.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Analyze numerical techniques, ideas and would be able to demonstrate the applications of these techniques to problems drawn from industry, management and other engineering fields.
2. Apply the numerical techniques to solve the differentiation and integration.
3. Analyze and solve ordinary differential equations for application in their field of engineering
4. Demonstrate the testing hypothesis in the real life.
5. Explain how to find the solution of industrial and agriculture problems using design of experiments.

Unit I NUMERICAL SOLUTION OF LINEAR EQUATIONS 9+3

Solution of algebraic and transcendental equations– Newton Raphson method - Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Matrix Inversion by Gauss Jordan method.

Unit II INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION 9+3

Interpolation with equal intervals - Newton's forward and backward difference formulae, Interpolation with unequal intervals - Lagrange's interpolation– Approximation of derivatives using interpolation polynomials – Numerical solution of single and double integrations using Trapezoidal and Simpson's rules.

Unit III NUMERICAL SOLUTION OF ODE GIVEN INITIAL VALUES 9+3

Ordinary differential equations: Initial value problems, Taylor series, fourth order Runge - Kutta methods, Predictor Corrector methods, Milne's and Adams Bash forth Method.

Unit IV TESTING OF HYPOTHESIS 9+3

Large sample test based on Normal distribution for single mean and difference of means – Tests based on t,chi-square and F distributions for testing means and variances –Contingency table (Test for Independency) - Goodness of fit.

Unit V DESIGN OF EXPERIMENTS 9+3

One way and two way classifications - Completely randomized design – Randomized block design – Latin square design.

Total Periods 45+15

Text/Reference Books:

1. Grewal. B.S., and Grewal. J.S., "Numerical methods in Engineering and Science", Khanna Publishers, 9th Edition, New Delhi, 2007.
2. Gerald. C. F., and Wheatley. P. O., "Applied Numerical Analysis", Pearson Education, Asia, 6th Edition, New Delhi, 2006.
3. Richard L. Burden, J. Douglas Faires and Annette Burden "Numerical Analysis" , Cengage Learning , 10th edition, 2015.
4. P. Kandasamy, K. Thilagavathy and K. Gunavathy (2005). Numerical Methods. S. Chand & Co. Ltd, Delhi.
5. Douglas. C. Montgomery and George. C. Runger "Applied Statistics and Probability for Engineers" John Wiley and Sons, 5th Edition, 2011.

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

Pre-Requisites : Knowledge of Engineering Mechanics

Objectives:

- To familiarize with various mechanisms and inversions
- To understand the velocity and acceleration of simple mechanisms
- To understand displacement, velocity and acceleration of follower motions of cams.
- To acquaint with basics of power transmission systems by gear trains
- To understand the basic functions of clutches, brakes and belt drives.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Develop and build mechanisms to provide specific motion
- CO2 :** Draw velocity and acceleration diagrams of various mechanisms.
- CO3 :** Draw Cam profile for the specific follower motion
- CO4 :** Select appropriate power transmission for specific application
- CO5 :** Analyze the effects of friction in motion transmission and in machine components

Unit I MECHANISMS

9

Introduction - Links - Pairs - Chain - Mechanism - Machine structure - Degrees of freedom - Four bar chains - Terminology and definition - Planer, Spherical and Spatial Mechanisms - Grashoff's law - Kutzbach criterion - Grubler's criterion for plane mechanism - Inversion of mechanisms - Four bar, single slider crank and double slider crank mechanisms

Unit II KINEMATICS OF MECHANISMS

9

Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method– Velocity and acceleration analysis of Four bar chain and single slider mechanism by relative velocity method and instantaneous centres method– Kennedy's theorem - Coriolis component of Acceleration

Unit III CAMS

9

Types of cams and followers - Follower motion - Uniform, Parabolic, SHM and cycloidal- Displacement diagrams - Cam profiles construction for roller, flat faced and knife edge follower types - Derivatives of Follower motion - circular arc and tangent cams – pressure angle and undercutting in cams.

Unit IV GEARS AND GEAR TRAINS

9

. Gears- Introduction, types= Spur gear terminology and definition – Law of gearing, Construction of Involute and Cycloid gear tooth profile - Gear tooth action – contact ratio – Interference and undercutting in gears - Gear trains: simple, compound, reverted and epicyclic - Velocity ratio and torque calculation in gear trains – Automobile differential.

Unit V FRICTION IN MACHINE ELEMENTS

9

Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads –Bearings and lubrication – Friction clutches – Belt and rope drives – Friction in brakes- Band and Block brakes.

Total Periods 45

LIST OF EXPERIMENTS:

1. Study of gear parameters.
2. Experimental study of velocity ratios of simple gear train.
3. Experimental study of velocity ratios of compound gear train.
4. Experimental study of velocity ratios of epicyclic gear train.
5. Experimental study of velocity ratios of differential gear train.
6. To study Kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker Mechanisms.
7. To study Kinematics of universal joint.
8. To draw cam profile and displacement diagram.
9. To study cam jump phenomenon.

S.No	Authir(s)	Title of the Book	Publisher	Year of Publication
1.	Rattan, S.S	Theory of Machines, 4th Edition	Tata McGraw-Hill	2014.
2.	Dr.R.K.Bansal and Dr.J. S. Brar,	A Text book of Theory of Machines	Laxmi publications, New Delhi	2011

S.No	Authir(s)	Title of the Book	Publisher	Year of Publication
1.	Uicker, J.J., Pennock G.R and Shigley, J.E.,	Theory of Machines and Mechanisms, 4th Edition,	Oxford University Press	2014.
2.	Ghosh. A and Mallick, A.K	Theory of Mechanisms and Machines, 3rd Edition	Affiliated East-West Pvt. Ltd., New Delhi	2006
3.	Thomas Bevan	Theory of Machines, 3rd Edition	CBS Publishers and Distributors	2005
4.	Ambekar A.G.,	Mechanisms and Machine Theory	Prentice Hall of India, New Delhi	2007

1. [nptel.ac.in/courses/Webcourse- contents/.../Kinematics%20of%20Machine/index.html](http://nptel.ac.in/courses/Webcourse-contents/.../Kinematics%20of%20Machine/index.html)
2. nptel.ac.in/courses/112104121/1
3. https://swayam.gov.in/nd1_noc20_me21

K1- Remember (Re), K2 – understand (Un), K3- Apply (Ap), K4- Analyse (An), K5- Evaluate (Ev), K6 – Create (Cr)

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

U19MET06	Engineering Materials and Metallurgy	L	T	P	C
		3	0	0	3

Pre-Requisites : None

Objectives:

- To impart knowledge on the crystal and phase structures of metals/alloys
- To study the heat treatment process employed for various materials
- To learn about metallic and non-metallic materials with their applications
- To impart knowledge on testing and characterising engineering materials
- To gain knowledge about composite and nano materials

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Understand the crystal structure and phase diagrams related to materials.
- CO2 :** Explore the knowledge about various heat treatment processes
- CO3 :** Understand the knowledge about the metallic and non-metallic materials
- CO4 :** Discuss about various material testing methods
- CO5 :** Exhibit the knowledge about the composite and nano materials.

INTRODUCTION AND CRYSTAL STRUCTURE 2

Introduction to material science – classification of Engineering materials – selection of materials – levels of structure. Crystal structure – fundamental concepts – unit cells – crystal systems – SC, BCC, FCC and HCP – structure determination. Crystal defects – grains and grain boundaries – grain size measurement – ASTM grain size number – Metallography – preparation of specimen for micro examination – Metallurgical microscopes.

Unit I PHASE DIAGRAMS AND PHASE TRANSFORMATIONS 9

Phase, Gibbs phase rule, Microstructure, Binary phase diagrams, Isomorphous systems, Conditions of unlimited solubility, Eutectic systems, Intermediate phases, Eutectoid and Peritectic reactions, Iron-Carbon diagram, Microstructures in Iron-Carbon alloys, Phase transformations, Isothermal transformation diagrams, Pearlite, Martensite and Bainite transformations. Continuous Cooling Transformation diagrams.

Unit II HEAT TREATMENT PROCESSES 9

Full, stress relief, recrystallisation and spheroidizing annealing – normalising, hardening and tempering of steel – phase transformation - Isothermal transformation (TTT) diagrams – cooling curves - CCR – CCT diagram - Hardenability, Jominy end quench test - Austempering, martempering – case hardening - carburising, nitriding, cyaniding, carbonitriding, flame and induction hardening - precipitation hardening.8

Unit III METALLIC AND NON-METALLIC MATERIALS 9

Classification, properties, microstructure, processing and applications of plain carbon steels & cast iron – effect of alloying elements on steel (Mn, Si, Cr, Mo, V, Ti & W) - stainless and tool steels - HSLA & maraging steels -Copper and its alloys - Brass, Bronze and Cupronickel – Aluminium and its alloys – Bearing alloys – Nickel and Nickel alloys, Monel metal, Super alloys, Titanium and Titanium alloys, Ceramics, Glasses, Refractories and its types.

Unit IV MECHANICAL TESTING AND CHARACTERISATION 8

Mechanical properties - stress strain curve for ferrous and non-ferrous alloys - Mechanism of plastic deformation, slip and twinning – types of fracture – Griffith theory - testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Rockwell and Vickers) - Impact test (Izod and Charpy) - Fatigue and creep tests - fracture toughness tests - characterisation techniques: Optical, SEM, XRD – Non-Destructive tests.

Unit V COMPOSITE MATERIALS AND NANO MATERIALS 8

Definition–function of matrix and reinforcement in composites–classification of composites based on reinforcement–types of composite materials–polymers, metallic and ceramic matrix composites. Law of mixtures. Comparison with conventional materials. Fabrication of metal matrix and ceramic matrix composites–properties and uses. Nanomaterials: preparation (bottom up and top down approaches), properties and applications – carbon nanotubes: types.

Text Books:

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Raghavan, V.	Materials Science and Engineering : A First course	PHI Learning	2015
2.	Donald R.Askeland, Pradeep P. Fulay and Wendelin J.Wright	Science and Engineering of Materials	Thomson brooks	2010
3.	William D. Callister, Jr.	Material Science and Engineering, Seventh Edition	John Wiley & Sons Inc. New Delhi,	2010

Reference Books:

S.No	Authir(s)	Title of the Book	Publisher	Year of Publication
1.	R.Balasubramanian	Callister's Material science and engineering	Wiley India pvt.ltd	2008
2.	Van Vlack	Elements of Material Science And Engineering	Pearson Education India,	2008
3.	Askeland, Fulay, Wright, and Balani	The Science of Engineering and Materials	Cengage learning	2012
4.	Kenneth G Budinski and Michael K Budinski	Engineering Materials: Properties and Selection	PHI learning private limited	2012
5.	Joel R. Fried.	Polymer Science and Technology". 3rd Edition	Prentice Hall	2014

Web URL(s):

1. www.nptel.iitm.ac.in.
2. www.sciencedaily.co

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

19MEE04	Thermal Engineering	L	T	P	C
		2	1	2	4
Pre-Requisites	: Knowledge of Basic Engineering Thermodynamics				
Note	: Use of standard refrigerant property data book, Steam Tables, Mollier diagram and Psychrometric chart is permitted				
Objectives:					
- To integrate the concepts, laws and methodologies from the first course in thermodynamics into analysis of cyclic processes - To provide in-depth study of thermodynamic principles, thermodynamics of state, basic thermodynamic relations, principle of psychrometry and properties of pure substances - To apply the thermodynamic concepts into various thermal application like IC engines, Steam Turbines, Compressors and Refrigeration and Air conditioning systems.					
Course Outcomes:					
At the end of this course, students will demonstrate the ability to					
CO1	Apply thermodynamic concepts to different air standard cycles and solve problems.				
CO2	Solve problems in single stage and multistage air compressors				
CO3	Explain the functioning and features of IC engines, components and auxiliaries				
CO4	Calculate performance parameters of IC Engines				
CO5	Explain the flow in Gas turbines and solve problems				
Unit I	INTERNAL COMBUSTION ENGINES	10			
Classification - working of four and two stroke engines - SI and CI engines – comparisons- Valve timing diagram and port timing diagram – Performance parameters and calculations and heat balance sheet.					
Unit II	STEAM NOZZLES AND TURBINES	9			
Flow of steam through nozzles, shapes of nozzles, effect of friction, critical pressure ratio, classification of steam turbine, compounding, velocity diagram for simple and multi-stage turbines (Description only)					
Unit III	AIR COMPRESSOR	8			
Classification and working principle of various types of compressors, work of compression with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency of reciprocating compressors, Multistage air compressor and inter cooling –work of multistage air compressor (Description only)					
Unit IV	PSYCHROMETRY	9			
Psychrometric properties, Psychrometric charts. Property calculations of air vapour mixtures by using chart - Psychrometric process – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing. Simple Applications					
Unit V	REFRIGERATION AND AIR CONITIONING	9			
Refrigerants – Vapour compression refrigeration cycle – super heat, sub cooling – Performance calculation – Working principle of vapour absorption system, Ammonia-water, Lithium bromide-water system (Description only) – Air conditioning system –Types and Working principles					
Total Periods		45			

LIST OF EXPERIMENTS:

1. Valve Timing and Port Timing diagrams.
2. Actual P-v diagrams of IC engines.
3. Performance Test on 4 – stroke Diesel Engine.
4. Heat Balance Test on 4 – stroke Diesel Engine.
5. Retardation Test on a Diesel Engine.
6. Determination of Flash Point and Fire Point of various fuels / lubricants.
7. Determination of COP of a refrigeration system
8. Performance test on a reciprocating air compressor
9. Experiments on Psychrometric processes
10. Study on Steam Generators and Turbines

Text Books:

S.No	Authir(s)	Title of the Book	Publisher	Year of Publication
1.	Rajput R.K	Thermal Engineering	S.Chand Publishers	2000
2.	Kothandaraman C P, Domkundwar S , Domkundwar A.V	A Course in Thermal Engineering	Dhanpat Rai & Sons	2002

Reference Books:

S.No	Authir(s)	Title of the Book	Publisher	Year of Publication
1.	Sarkar B K	Thermal Engineering	Tata McGraw – Hill Publishing Company Limited	2007
2.	Arora C P	Refrigeration and Air Conditioning	Tata McGraw – Hill Publishing Company Limited	1994
3.	Ganesan V	Internal Combustion Engines	Tata McGraw – Hill Publishing Company Limited	2007
4.	Rudramoorthy R	Thermal Engineering	Tata McGraw – Hill Publishing Company Limited	2003

Web URL(s):

1. <https://nptel.ac.in/courses/112106133/>
2. <https://nptel.ac.in/courses/112/103/112103275/>
3. <https://www.mechanicalgeek.com/thermal-engineering-by-rk-rajpoot-pdf-download/>

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

Pre-Requisites : None

Objectives:

- To understand the concept and basic mechanics of metal cutting process.
- To provide knowledge on the working of standard machine tools such as lathe, shaping, milling, drilling, grinding and broaching machine tools for manufacturing of various components.
- To understand the basic concepts of Computer Numerical Control (CNC) of machine tools and CNC Programming

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Explain the mechanism of material removal processes
- CO2 :** Describe the constructional and operational features of centre lathe, other special purpose lathes, shaper and planer machines.
- CO3 :** Describe the constructional and operational features of milling, drilling and gear cutting machines
- CO4 :** Explain the grinding and other super finishing processes.
- CO5 :** Summarize numerical control of machine tools and write a part program.

Unit I TURNING AND DRILLING MACHINES 9

Capstan and turret lathes – construction - indexing mechanism - operations - working principle of single and multi - spindle automats - Drilling –reaming – boring - Tapping

Unit II SHAPING AND PLANING MACHINES 9

Shaping and planing machines – types – construction - mechanism – principle of operation – different shaping operations.

Unit III MILLING AND GEAR CUTTING MACHINES 9

Milling operations-types of milling cutter. Gear cutting – forming and generation principle and construction of gear milling ,hobbing and gear shaping processes –finishing of gears

Unit IV ABRASIVE PROCESS AND BROACHING 9

Abrasive processes: grinding wheel – specifications and selection, types of grinding process– cylindrical grinding, surface grinding, centreless grinding and internal grinding- Typical applications – concepts of surface integrity, broaching machines: broach construction – push, pull, surface and continuous broaching machines

Unit V CNC MACHINING 9

Numerical Control (NC) machine tools – CNC types, constructional details, special features, machining centre, part programming fundamentals CNC – manual part programming – micromachining – wafer machining.

Total Periods 45

Text Books:

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Hajra Chowdary, S.K., and Hajra Chowdary, A.K.,	Elements of Workshop Technology Vol.II.,	Asia Publishing House, Bombay	2003
2.	Rao. P.N	Manufacturing Technology - Metal Cutting and Machine Tools, 3 rd Edition	Tata McGraw-Hill, New Delhi	2013

Reference Books:

S.No	Authir(s)	Title of the Book	Publisher	Year of Publication
1.	Jain R.K. and Gupta S.C	Production Technology	Khanna Publishers, New Delhi	1999
2.	HMT	Production Technology	Tata McGraw Hill	1998
3.	Roy. A.Lindberg,	Process and Materials of Manufacture,” Fourth Edition,	PHI/Pearson Education	2006

Web URL(s):

1. https://swayam.gov.in/nd1_noc20_me16/preview
2. https://swayam.gov.in/nd1_noc19_me46/preview
3. <https://nptel.ac.in/courses/112105233/>
4. <https://nptel.ac.in/courses/112105211/>

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

L	T	P	C
0	0	4	2

- Demonstration and study of the various manufacturing processes..
- Study of various General Purpose Machine Tools..
- Study of various Special Purpose Machine Tools.
- Understanding of machine tool capabilities.
- Complete understanding of various grinding and abrasive processes.

At the end of this course, students will demonstrate the ability

C02 : To gain hands on experience on various manufacturing processes

CO4 : To give a practical hands on exposure in the various machine tools to manufacture Gears

C05 : To evaluate various machine tool cutting parameters

1. Estimation of machining time for Facing, plain turning and step turning
2. Estimation of machining time for Taper turning using compound rest, Tailstock set over, etc
3. Estimation of machining time for Single and Multi-start V thread cutting and knurling.
4. Estimation of machining time for Boring and internal thread cutting.
5. Preparation of Sand Mould with solid pattern.
6. Preparation of Sand Mould with split pattern.
7. Preparation of Sand Mould with Core.
8. Manufacturing of Gear by Gear Milling.
9. Manufacturing of Gear by Gear Hobbing.
10. Two or more exercises in Shaper, Slotter, Planner, Drilling, Milling Machines (example: Round to Square in Shaper, Internal keyway cutting in Slotter, Drilling, Reaming and Tapping using Drilling machine, Keyway milling in Milling machine)
11. Two or More Exercises in Grinding / Abrasive machining (Example: Surface Grinding , Cylindrical Grinding, Centreless Grinding)
12. Measurement of Shear Angle, Cutting Force and Tool Wear

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

U19MTT01

Environmental Science

L	T	P	C
2	0	0	0

Pre - : Applied Chemistry
Requisites

Objectives:

- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

Course Outcomes:

At the end of this course, the student will be able to

- CO1 :** To study the nature and facts about environment.
- CO2 :** To finding and implementing scientific, technological, economic and political solutions to environmental problems.
- CO3 :** To study the interrelationship between living organism and environment.
- CO4 :** To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- CO5 :** To study the dynamic processes and understand the features of the earth's interior and surface.

Unit I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 5

Definition - scope of environment - concept of an ecosystem - structure and function of an ecosystem - producers, consumers and decomposers - ecological succession processes - Introduction, types, characteristic features, structure and function of the various ecosystems. Introduction to biodiversity - definition: genetic, species and ecosystem diversity - threats to biodiversity - endangered and endemic species of India - conservation of biodiversity: In - situ and ex - situ conservation of biodiversity.

Unit II NATURAL RESOURCES 7

Forest resources: Use and over - exploitation, deforestation, case studies - timber extraction, mining, dams and their effects on forests and tribal people - Water resources: Use and overutilization of surface and ground water - Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies - Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer - pesticide problems, water logging, salinity, case studies - Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

Unit III ENVIRONMENTAL POLLUTION**7**

Definition – Sources, causes, effects and control measures of Water pollution : Physical and chemical properties of terrestrial and marine water and their environmental significance; Water quality parameters - physical, chemical and biological; absorption of heavy metals - Air pollution - Chemical and photochemical reactions in the atmosphere - Control of particulate and gaseous emission, Control of SOX, NOX, CO and HC - Soil pollution - causes, effects and control measures - Marine pollution - Noise pollution - Thermal pollution - Nuclear hazards - role of an individual in prevention of pollution.

Unit IV SOCIAL ISSUES AND THE ENVIRONMENTAL LEGISLATION**6**

From unsustainable to sustainable development - urban problems related to energy - water conservation, rain water harvesting, water shed management - resettlement and rehabilitation of people; its problems and concerns - role of non - governmental organization - environmental ethics: Issues and possible solutions. Environment protection act - Air act - Water act - Wildlife protection act - Forest conservation act - The Biomedical Waste (Management and Handling) Rules; 1998 and amendments - scheme of labeling of environmentally friendly products (Eco mark). Disaster management: floods, earthquake, cyclone and landslides.

Unit V ENVIRONMENT IMPACT ASSESSMENT**5**

Environmental impact analysis (EIA) - Environmental Impact Statement (EIS) - Legal and Regulatory aspects in India – Types and limitations of EIA - Terms of Reference in EIA - Issues in EIA - national – cross sectoral - social and cultural - Case studies of EIA of developmental projects.

Total Periods 30**Text Books:**

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Benny Joseph	Environmental Science and Engineering	Tata McGraw Hill, New Delhi	2006
2.	Gilbert M.Masters	Introduction to Environmental Engineering and Science	2nd edition, Pearson Education	2004

Semester 5

U19MEE05**Dynamics of Machinery**

L	T	P	C
2	1	2	4

Prerequisites : Knowledge of Engineering Mechanics and Kinematics of Machinery

Objectives:

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

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Calculate static and dynamic forces of mechanisms.

CO2 : Calculate the balancing masses and their locations in rotating and reciprocating machines.

CO3 : Compute the frequency of free vibration.

CO4 : Compute the frequency of forced vibration and damping coefficient.

CO5 : Calculate the speed and lift of the governor as well as estimate the gyroscopic effect on automobiles, ships and airplanes.

Unit I FORCE ANALYSIS**9**

Dynamic force analysis – Inertia force and Inertia torque– D Alembert's principle –Dynamic Analysis in reciprocating engines – Gas forces – Inertia effect of connecting rod– Bearing loads – Crank shaft torque – Turning moment diagrams –Fly Wheels – Flywheels of punching presses- Dynamics of Cam-follower mechanism.

Unit II BALANCING**9**

Static and dynamic balancing – Balancing of rotating masses – Balancing a single cylinder engine – Balancing of Multi-cylinder inline, V-engines – Partial balancing in engines – Balancing of linkages – Balancing machines-Field balancing of discs and rotors.

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– Torsional vibration of shaft – Critical speeds of shafts – Torsional vibration – Two and three rotor torsional systems.

Unit IV FORCED VIBRATION**9**

Response of one degree freedom systems to periodic forcing – Harmonic disturbances – Disturbance caused by unbalance – Support motion –transmissibility – Vibration isolation vibration measurement.

Unit V MECHANISM FOR CONTROL**9**

Governors – Types – Centrifugal governors – Gravity controlled and spring controlled centrifugal governors – Characteristics – Effect of friction – Controlling force curves. Gyroscopes –Gyroscopic forces and torques – Gyroscopic stabilization – Gyroscopic effects in Automobiles, ships and airplanes.

Total Periods 45

LIST OF EXPERIMENTS

1. Determination of Mass moment of inertia of Flywheel.
2. Determination of Mass Moment of Inertia of axisymmetric bodies using Turn Table apparatus.
3. Determination of Mass Moment of Inertia using bifilar suspension and compound pendulum.
4. Study of gyroscopic effect and couple using Motorized gyroscope.
5. Determination of range sensitivity, effort etc., for Watts, Porter, Proell and Hartnell Governors.
6. Determination of natural frequency and damping co-efficient of single degree of freedom spring-mass System.
7. Determination of natural undamped frequency of Equivalent Spring mass system.
8. Determination of torsional undamped natural frequency of single and double rotor systems.
9. Determination of critical speeds of shafts with concentrated loads.
10. Determination of natural undamped frequency of Transverse vibration of Free-Free beam – with and without concentrated masses.
11. Study of Balancing of rotating masses and reciprocating masses.

Total Periods 15

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Rattan. S.S	Theory of Machines, 4 th Edition	Tata McGraw-Hill, New Delhi	2014
2	F. B. Sayyad	Dynamics of Machinery	Tech-Max Educational resources, McMillan Publishers India Ltd	2011

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Uicker, J.J., Pennock G.R and Shigley, J.E.,	Theory of Machines and Mechanisms, 4th Edition,	Oxford University Press	2014
2	Khurmi, R. S	Theory of Machines, 14 th Edition	S Chand Publications,	2005
3	V.Ramamurthi	Mechanics of Machines	Narosa Publishing House	2002
4	Ghosh. A and Mallick, A.K	Theory of Mechanisms and Machines, 3rd Edition	Affiliated East-West Pvt. Ltd., New Delhi	2006
5	Rao.J.S. and Duggipati.R.V	Mechanisms and Machine Theory	Wiley-Eastern Ltd., New Delhi	1992

Web URL(s)

1. <https://nptel.ac.in/courses/112104114/>
2. https://swayam.gov.in/nd1_noc19_ae09/preview

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

U19MEE06	Heat and Mass Transfer	L	T	P	C
	(Use of HMT data book permitted)	2	1	2	4

Prerequisites : Knowledge of Engineering Thermodynamics

Objectives:

- To understand the mechanism of heat transfer under steady and transient condition
- To understand the concepts of heat transfer through the extended surfaces
- To learn the thermal analysis and sizing of heat exchangers
- To expose the mechanism of free and forced convection
- To understand the basic concept of mass transfer.
- To explain diffusion and convective mass transfer

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Apply heat conduction equations to different surface configurations under steady state and transient conditions and solve problems.
- CO2 :** Apply free and forced convective heat transfer correlations to internal and external flows through/over various surface configurations and solve problems.
- CO3 :** Explain the phenomena of boiling and condensation, apply LMTD and NTU methods of thermal analysis to different types of heat exchanger configurations and solve problems
- CO4 :** Explain basic laws for Radiation and apply these principles to radiative heat transfer between different types of surfaces to solve problems.
- CO5 :** Apply diffusive and convective mass transfer equations and correlations to solve problems for different applications.

UNIT I CONDUCTION 9

Basic concepts – mechanisms of heat transfer General Differential equation of Heat Conduction– Cartesian and cylindrical Coordinates – One Dimensional Steady State Heat Conduction — plane and Composite Systems – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis.

UNIT II CONVECTION 9

Free and Forced Convection – Heat transfer coefficients, Boundary Layer concepts. Free and Forced Convection during external flow over vertical and horizontal Plates and Cylinders and Internal flow through tubes.

UNIT III RADIATION 9

Law of radiation – Stefan Boltzmann law, Kirchhoff's law, Black Body Radiation – Grey body radiation - Shape Factor – Electrical Analogy – Radiation Shields.

UNIT IV PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS 9

Boiling – modes - Correlations in boiling Condensation - Nusselt's theory of condensation – Correlations in condensation, Heat Exchanger - Types - Overall Heat Transfer Coefficient – Fouling Factors - Analysis – LMTD method - NTU method.

UNIT V MASS TRANSFER 9

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.

Total Periods 45

LIST OF EXPERIMENTS

1. Thermal conductivity measurement using guarded plate apparatus.
2. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
3. Determination of heat transfer coefficient under natural convection from a vertical cylinder.
4. Determination of heat transfer coefficient under forced convection from a tube.
5. Heat transfer from pin-fin apparatus
6. Determination of Stefan – Boltzmann constant.
7. Determination of emissivity of a grey surface.
8. Effectiveness of Parallel / counter flow heat exchanger

Total Periods 15

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Yunus A. Cengel	Heat Transfer A Practical Approach, 5th Edition	Tata McGraw Hill, New Delhi	2015
2	R.C. Sachdeva	Fundamentals of Engineering Heat & Mass transfer	New Age International Publishers	2009

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Frank P. Incropera and David P. Dewitt	Fundamentals of Heat and Mass Transfer	John Wiley & Sons	1998
2	Nag, P.K	Heat Transfer	Tata McGraw Hill, New Delhi	2002
3	Ozisik, M.N	Heat Transfer	McGraw Hill Book Co	1994
4	Holman, J.P	Heat and Mass Transfer	Tata McGraw Hill	2000
5	R. K. Rajput	Heat and Mass Transfer	S Chand and Company, New Delhi	2007
6	C. P. Kothandaraman and S. Subramanyan	Fundamentals of Heat and Mass Transfer, Rev.3rd edition	New Age International Pvt Ltd, New Delhi,	2006

Web URL(s)

1. <https://nptel.ac.in/courses/112/101/112101097/>
2. <https://nptel.ac.in/courses/112/108/112108149/>
3. <https://nptel.ac.in/courses/112/101/112101002/>
4. <https://nptel.ac.in/courses/112/104/112104159/>
5. <http://www.nptelvideos.in/2012/12/heat-and-mass-transfer.html>

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

U19MET08	Design of Machine Elements	L	T	P	C
		2	1	0	3

Prerequisites : Knowledge of Engineering Mechanics

Objectives:

- To familiarize the various steps involved in the Design Process
- To understand the principle involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.
- To learn to use standard practices and standard data
- To learn to use catalogues and standard machine components

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Explain the influence of steady and variable stresses in machine component design
- CO2 :** Apply the concepts of design to shafts, keys and couplings
- CO3 :** Apply the concepts of design to temporary and permanent joints
- CO4 :** Apply the concepts of design to energy absorbing members, connecting rod and crank shaft.
- CO5 :** Apply the concepts of design to bearings

Unit I STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS 9

Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading – curved beams – crane hook and ‘C’ frame- Factor of safety - theories of failure – Design based on strength and stiffness – stress concentration – Design for variable loading.

Unit II SHAFTS AND COUPLINGS 9

Design of solid and hollow shafts based on strength, rigidity and critical speed – Keys, keyways and splines - Rigid and flexible couplings.

Unit III TEMPORARY AND PERMANENT JOINTS 9

Threaded fasteners - Bolted joints including eccentric loading, Knuckle joints, Cotter joints – Welded joints, riveted joints for structures - theory of bonded joints.

Unit IV ENERGY STORING ELEMENTS AND ENGINE COMPONENTS 9

Various types of springs, optimization of helical springs - rubber springs - Flywheels considering stresses in rims and arms for engines and punching machines- Connecting Rods and crank shafts.

Unit V BEARINGS 9

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi and Boyd graphs, -- Selection of Rolling Contact bearings

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Bhandari V	Design of Machine Elements, 4 th Edition	Tata McGraw-Hill , New Delhi	2016
2	Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett	Mechanical Engineering Design, 9 th Edition	Tata McGraw-Hill, New Delhi	2011

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Sundararamoorthy T. V. and Shanmugam .N,	Machine Design	Anuradha Publications, Chennai,	2015
2.	Robert C. Juvinall and Kurt M. Marshek	Fundamentals of Machine Design,4th Edition	John-Wiley	2005
3.	R.B. Patel	Design of Machine Elements	MacMillan Publishers India P Ltd., Tech-Max Educational resources,	2011
4.	P.C. Gope	Machine Design – fundamental and Application	PHI learning private ltd, New Delhi	2012
5.	Ansel Ugural	Mechanical Design – An Integral Approach,1st Edition	Tata McGraw-Hill, New Delhi	2003

Web URL(s)

1. <https://nptel.ac.in/courses/112/105/112105125/>
2. <https://nptel.ac.in/courses/112/105/112105124/>
3. <https://nptel.ac.in/courses/112/106/112106137/>

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

U19MET09

Automobile Engineering

L	T	P	C
3	0	0	3

Objectives:

- To understand the construction and working principle of various parts of an automobile.
- To have the practice for assembling and dismantling of engine parts and transmission system

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Recognize the various parts of the automobile and their functions and materials.
- CO2 :** Discuss the engine auxiliary systems and engine emission control.
- CO3 :** Distinguish the working of different types of transmission systems.
- CO4 :** Explain the Steering, Brakes and Suspension Systems.
- CO5 :** Predict possible alternate sources of energy for IC Engines.

Unit I VEHICLE DESIGN AND ENGINES 9

Types of automobiles vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics, IC engines –components-functions and materials, Variable Valve Timing (VVT).

Unit II FUEL INJECTION SYSTEMS 9

Electronically controlled gasoline injection system for SI engines - EFi, MPFi, GDi , Electronically controlled diesel injection system – CRDI, Unit injector system, Rotary distributor type , Turbo chargers (WGT, VGT), Engine emission control by three way catalytic converter system, Emission norms (Euro and BS).

Unit III POWER TRANSMISSION SYSTEMS 9

Clutch-types and construction, gear boxes- manual and Automatic transmission with intelligent electronic control systems - 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, Bio-diesel, 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

Note: Practical Training in dismantling and assembling of Engine parts and Transmission Systems should be given to the students.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Jain K.K. and Asthana .R.B	Automobile Engineering	Tata McGraw Hill,New Delhi,	2002
2	Kirpal Singh	Automobile Engineering Vol 1&2 , 13 th Edition,	Standard Publishers, New Delhi	2014

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Ganesan V	Internal Combustion engines, 3 rd Edition	Tata McGraw Hill Publishers, New Delhi,	2012
2	Heinz Heisler	Advanced Engine Technology	SAE International Publications, USA	1998
3	Joseph Heitner	Automotive Mechanics, 2 nd Edition,	East-West Press, New Delhi,	1999
4	Martin W, Stockel and Martin T Stockle	Automotive Mechanics Fundamentals	The Good heart - Will Cox Company Inc, USA	1978
5	Newton, Steeds and Garet	Motor Vehicles	Butterworth Publishers	1989

Web URL(s)

1. <https://nptel.ac.in/courses/107/106/107106088/>

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

U19MTT02	Indian Constitution	L	T	P	C
		3	0	0	0

Objectives:

- To impart the knowledge about Indian Constitution and its features..
- To learn about the functions of local administration. .
- To impart the knowledge about functions of State and Union governments/

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Obey the rules and regulations laid down by the state and union governments.

CO2 : Behave as a loyal citizen of the country

CO3 : Become a respectful leader in near future.

CO4 : Understand all the rules and regulations to become a good administrator..

CO5 : Understand the various procedures and processes of election Commission.

Unit I INTRODUCTION 9

Constitution- meaning of the term, Indian Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy

Unit II UNION GOVERNMENT AND ITS ADMINISTRATION 9

Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha

Unit III STATE GOVERNMENT AND ITS ADMINISTRATION 9

Governor: Role and Position, Chief Minister and Council of ministers, State Secretariat: Organization, Structure and Functions

Unit IV LOCAL ADMINISTRATION 9

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati raj: Introduction, PRI: Zila Pachayat, Elected officials and their roles, CEO Zila Pachayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

Unit V ELECTION COMMISSION 9

Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women

Total Periods 45

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	D.D. Basu	Introduction to the Constitution of India, 23 rd Edition	Lexis Nexis, Gudgaon	2015
2.	A. Avasti and A.P. Avasti	Indian Administration	Lakshmi Narain Agarwal Educational Publishers, Agra	2017
3.	S.R. Maheswari	Indian Administration, 6 th Edition	Orient Blackswan, Chennai	2004

Web Url(s)

1. <https://www.iitk.ac.in/wc/data/coi-4March2016.pdf>
2. https://www.india.gov.in/sites/upload_files/npi/files/coi_part_full.pdf

Semester 6

Objectives:

- To provide knowledge on various Metrological equipments available to measure the dimension of the components.
- To provide knowledge on the correct procedure to be adopted to measure the dimension of the components.

Course Outcomes: Upon completing this course, the students

- CO1 :** Understand the objectives of metrology, methods of measurement, standards of measurement & various measurement parameters.
- CO2 :** Explain tolerance, limits of size, fits, geometric and position tolerances, gauges and their design. Understand the working principle of different types of comparators.
- CO3 :** Describe measurement of major & minor diameter, pitch, angle and effective diameter of screw threads.
- CO4 :** Explain measurement systems, transducers, intermediate modifying devices and terminating devices.
- CO5 :** Describe functioning of force, torque, pressure, strain and temperature measuring devices.

Unit I INTRODUCTION TO METROLOGY**9**

Definition, objectives of metrology, Material Standards, Wavelength Standards, Classification of standards, Line and End standards, Calibration of End bars. Numerical examples. Linear measurement and angular measurements: Slip gauges-Indian standards on slip gauges, Adjustable slip gauges, Wringing of slip gauges, Measurement of angle-sine bar, Sine center, Angle gauges, Optical instruments for angular measurements. Autocollimator-Applications for measuring straightness and squareness.

Unit II SYSTEM OF LIMITS, FITS, TOLERANCE AND GAUGING**9**

Definitions- Tolerance analysis-Inter changeability and Selective assembly. Class and grade of tolerance- Fits- Types of fits. Hole base system & shaft base system. Taylor's principle, Types of limit gauges, Numerical on limit gauge design. Comparators: Functional requirements, Classification, Mechanical- Johnson Mikrokator, Sigma comparators, Dial indicator, Electrical comparators, LVDT, Pneumatic comparators- Solex comparators, Optical comparators.

Unit III MEASUREMENT OF SCREW THREAD AND GEAR**9**

Terminology of screw threads, Measurement of major diameter, Minor diameter, Pitch, Angle and Effective diameter of screw threads by 2- wire and 3-wire methods, Best size wire. Screw thread gauges, Toolmaker's microscope. Gear tooth Measurements: Tooth thickness measurement using constant chord method, Addendum, Comparator method and Base tangent method, Measurement of pitch, Concentricity, Run out and In volute profile. Gear roll tester for composite error.

Unit IV BASIC CONCEPTS OF MEASUREMENT SYSTEM AND METHODS**9**

Definition, Significance of measurement, Generalized measurement system, Static characteristics-Accuracy, Precision, Calibration, Threshold, Sensitivity, Hysteresis, Repeatability, Linearity, Loading effect, Dynamic characteristics- System response, Time delay. Errors in measurement, Classification of errors. Transducers: Transfer efficiency, Primary and Secondary transducers, Electrical transducers, Mechanical, Electronic transducers, Relative comparison of each type of transducers. Intermediate Modifying and Terminating Devices: Mechanical systems, Inherent problems, Electrical intermediate modifying devices, Input circuitry, Ballast circuit, Electronic amplifiers. Terminating devices, Cathode ray oscilloscope, Oscillographs.

Unit V APPLIED MECHANICAL MEASUREMENTS**9**

Measurement of force, Torque, Pressure, Types of Dynamometers, Absorption dynamometer, Prony brake and Rope brake dynamometer, and Power Measuring Instruments. Use of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge. Measurement of strain and temperature: Theory of strain gauges, Types, Electrical resistance strain gauge, Preparation and mounting of Strain gauges, Gauge factor, Methods of strain measurement, temperature compensation, Resistance thermometers, Thermocouple, Law of thermocouple, Pyrometer, Optical pyrometer.

Total Periods: 45

List of Experiments

1. Calibration and use of measuring instruments – Vernier caliper, micrometer- Vernier height gauge – using gauge blocks
2. Calibration and use of measuring instruments – depth micrometer, bore gauge, telescopic gauge
3. Measurement of linear dimensions using Comparators
4. Measurement of angles using bevel protractor and sine bar
5. Measurement of screw thread parameters – Screw thread Micrometers and Three wire method (Floating carriage micrometer)
6. Measurement of gear parameters – using gear tooth vernier caliper
7. Non-contact (Optical) measurement using Toolmaker's microscope / Profile projector.
8. Measurement of Surface finish in components manufactured using various processes (turning, milling, grinding, etc.,) using stylus based instruments.
9. Measurement of force
10. Measurement of torque
11. Measurement of temperature

Total Periods: 15

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Gupta. I.C.	Engineering Metrology	Dhanpatrai Publications	2005
2	Jain R.K.	Engineering Metrology	Khanna Publishers	2009

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Beckwith, Marangoni, and Lienhard.	Mechanical Measurements	Pearson Education	2014
2	Donald Peckman	Industrial Instrumentation	Wiley Eastern	2004
3	Alan S. Morris	The essence of Measurement	Prentice Hall of India	1996
4	Charles Reginald Shot bolt	Metrology for Engineers, 5th edition,	Cengage Learning EMEA,	1990

Web URL(s)

1. <https://nptel.ac.in/courses/112/106/112106179/>
2. <https://nptel.ac.in/courses/112/104/112104250/>
3. <https://nptel.ac.in/courses/112/106/112106139/>
4. <https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-me70/>

U19MEE08	Finite Element Analysis	L	T	P	C
		2	1	2	4

Prerequisites : Knowledge of Strength of Materials

Objectives:

- To introduce the concepts of Mathematical Modeling of Engineering Problems.
- To appreciate the use of FEM to a range of Engineering Problems.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Summarize the basics of finite element formulation.
- CO2 :** Apply finite element formulations to solve one dimensional Problems.
- CO3 :** Apply finite element formulations to solve two dimensional scalar Problems.
- CO4 :** Apply finite element method to solve two dimensional Vector problems.
- CO5 :** Apply finite element method to solve problems on iso parametric element and dynamic Problems.

Unit I INTRODUCTION 9

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems–Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

Unit II ONE-DIMENSIONAL PROBLEMS 9

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices - Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation –Transverse deflections and Natural frequencies of beams.

Unit III TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS 9

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non circular shafts –Quadrilateral elements – Higher Order Elements.

Unit IV TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS 9

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations - Plate and shell elements.

Unit V ISOPARAMETRIC FORMULATION 9

Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.

Total Periods 45

LIST OF EXPERIMENTS

1. MATLAB basics, dealing with matrices, Graphing-Functions of one variable and two variables.
2. Use of Mat lab to solve simple problems in vibration.
3. Mechanism Simulation using Multibody Dynamic software.
4. Force and Stress analysis using link elements in Trusses, cables etc.
5. Stress and deflection analysis in beams with different support conditions.
6. Stress analysis of flat plates and simple shells.
7. Stress analysis of axi – symmetric components.
8. Thermal stress and heat transfer analysis of plates.
9. Thermal stress analysis of cylindrical shells.
10. Vibration analysis of spring-mass systems.
11. Model analysis of Beams.
12. Harmonic, transient and spectrum analysis of simple systems.

Total Periods 15

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Reddy. J.N	An Introduction to the Finite Element Method	Tata McGraw-Hill, New Delhi	2005
2	Seshu, P	Text Book of Finite Element Analysis	Prentice-Hall of India Pvt. Ltd., New Delhi	2007

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Bhatti Asghar M	Fundamental Finite Element Analysis and Applications	John Wiley & Sons	2013
2	Chandrupatla & Belagundu	Introduction to Finite Elements in Engineering	Prentice Hall College Div	1990
3	Logan, D.L.	A first course in Finite Element Method	Thomson Asia Pvt. Ltd	2002
4	Rao, S.S.	The Finite Element Method in Engineering	Butterworth Heinemann	2004
5	Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt	Concepts and Applications of Finite Element Analysis	Wiley Student Edition	2002

Web URL(s)

1. <https://nptel.ac.in/courses/112/104/112104115/>

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

U19MET08	Design of Transmission Systems	L	T	P	C
	(Use of PSG Design Data Book permitted)	2	1	0	3

Objectives:

- To gain knowledge on the principles and procedure for the design of Mechanical power Transmission components.
- To understand the standard procedure available for Design of Transmission of Mechanical elements
- To learn to use standard data and catalogues

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Apply the concepts of design to belts, chains and rope drives.
- CO2 :** Apply the concepts of design to spur, helical gears
- CO3 :** Apply the concepts of design to worm and bevel gears
- CO4 :** Apply the concepts of design to gear boxes.
- CO5 :** Apply the concepts of design to cams, brakes and clutches

Unit I DESIGN OF FLEXIBLE ELEMENTS 9

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

Unit II SPUR GEARS AND PARALLEL AXIS HELICAL GEARS 9

Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects – Fatigue strength - Factor of safety - Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces for helical gears.

Unit III BEVEL, WORM AND CROSS HELICAL GEARS 9

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits-terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

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 - Constant mesh gear box - Speed reducer unit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.

Unit V CAMS, CLUTCHES AND BRAKES 9

Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses. Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches-Electromagnetic clutches. Band and Block brakes - external shoe brakes – Internal expanding shoe brake.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Bhandari V	Design of Machine Elements, 4th Edition	Tata McGraw-Hill Book Co,	2016
2	Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett	Mechanical Engineering Design, 9th Edition,	Tata McGraw-Hill, New Delhi	2011

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Sundararajamoorthy T. V. and Shanmugam .N,	Machine Design	Anuradha Publications, Chennai,	2015
2	Robert C. Juvinall and Kurt M. Marshek	Fundamentals of Machine Design ,4th Edition	John-Wiley	2005
3	Prabhu. T.J.	Design of Transmission Elements	Mani Offset, Chennai	2000
4	Orthwein W	Machine Component Design	Jaico Publishing Co	2003
5	Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger	Design of Machine Elements,8th Edition	Prentice Hall,	2003

Web URL(s)

1. <https://nptel.ac.in/courses/112/106/112106137/>
2. <https://nptel.ac.in/courses/112/105/112105234/>
3. <https://nptel.ac.in/courses/112/105/112105125/>
4. <https://nptel.ac.in/courses/112/105/112105124/>

COs	POs												PSOs	
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CO1	3	2	3	1	-	-	-	-	1	-	-	2	3	2
CO2	3	2	3	1	-	-	-	-	1	-	-	2	3	2
CO3	3	2	3	1	-	-	-	-	1	-	-	2	3	2
CO4	3	2	3	1	-	-	-	-	1	-	-	2	3	2
CO5	3	2	3	1	-	-	-	-	1	-	-	2	3	2
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

U19MEJ01	Design and Fabrication Project	L	T	P	C
		0	0	6	3

Objectives:

- To develop ability to apply the learned concepts of engineering in designing a working model, to get hands on training in the fabrication of designed models and to teach for the demonstration of their work through presentations

Course Outcome(s):

- Upon completion of the course the student will be able to design, fabricate and demonstrate a working model or real product/process

Guidelines for the conduct of Course

- The students in convenient groups of not more than 4 members have to select a new product/process/process add-on/working model etc. for design and fabrication.
- Every project work shall have a guide who must be the member of the faculty of the department and if essential with an industry guide who may act as co-guide.
- Title of the project must illustrate that something is designed and fabricated
- Three review meetings may be adopted by the head of the department through a project coordinator who is appointed by him for internal assessments
- The students are required to design and fabricate the chosen item in the college and demonstrate its working apart from submitting the project report. The report should contain assembly drawing, parts drawings, process charts relating to fabrication.
- At the end of the semester, the project work shall be evaluated based on oral presentation, the project report and demonstration of working model jointly by external and internal examiners constituted by the Head of the Department.

Total: 60 Periods

Semester 7

Objectives:

- To provide knowledge about Total Quality Management (TQM), TQM tools and Quality systems.

Course Outcomes: Upon completing this course, the students will be able to

- CO1 :** Develop an understanding on quality management philosophies and frameworks
- CO2 :** Adopt TQM methodologies for continuous improvement of quality
- CO3 :** Measure the cost of poor quality, process effectiveness and efficiency to identify areas for improvement.
- CO4 :** Apply benchmarking and business process reengineering to improve management processes.
- CO5 :** Determine the set of indicators to evaluate performance excellence of an organization

Unit I BASIC CONCEPTS 9

Definition of Quality, Dimensions of Quality, Definition of Total quality management, Quality Planning, Quality costs – Analysis, Techniques for Quality Costs, Basic concepts of Total Quality Management.

Unit II HISTORICAL REVIEW OF TQM 9

Quality Council. Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation, Benefits of TQM, Characteristics of successful quality leader, Contributions of Gurus of TQM,

Unit III TQM PRINCIPLES 9

Customer satisfaction - Customer Perception of Quality, Customer Complaints, Service Quality. Customer Retention, Employee Involvement - Motivation, Empowerment teams, Continuous Process Improvement - Juran Trilogy, PDCA Cycle, Kaizen, Supplier Partnership - Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures.

Unit IV TQM TOOLS 9

Benchmarking - Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) - House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) - Concept, Improvement Needs, FMEA - Stages of FMEA The seven tools of quality, Process capability, Concept of six sigma, New seven management tools,

Unit V QUALITY SYSTEMS 9

Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System - Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 - Concept, Requirements and Benefits - Case Studies

Total Periods: 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Subburaj Ramasamy	Total Quality Management	Tata McGraw Hill Publishing Company Ltd., New Delhi,	2005
2	Narayana V and Sreenivasan N.S.,	Quality Management - Concepts and Tasks	<i>New Age International</i> , Delhi,	2009

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Suganthi.L and Anand Samuel	Total Quality Management	Prentice Hall (India) Pvt. Ltd.,	2006
2	Janakiraman. B and Gopal .R.K	Total Quality Management	Prentice Hall (India) Pvt. Ltd.,	2006
3	Dale H.Besterfiled	Total Quality Management	<i>Pearson Education,</i> Delhi	2006
4	James R. Evans and William M. Lindsay	The Management and Control of Quality First Indian Edition	Cengage Learning New Delhi	2012

Web URL(s)

1. <https://nptel.ac.in/courses/110/104/110104080/>
2. <https://nptel.ac.in/courses/110/104/110104085/>
3. <https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-mg39/>

COs	POs												PSOs	
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CO2	3	-	-	3	3	3	-	2	3	2	-	-	2	2
CO3	3	-	-	3	3	3	-	2	3	2	-	-	2	2
CO4	3	-	-	3	3	3	-	2	3	2	-	-	2	2
CO5	3	-	-	3	3	3	-	2	3	2	-	-	2	2
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

Objectives:

- To impart knowledge about the elements and techniques involved in Mechatronics systems which are very much essential to understand the emerging field of automation.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Explain the functioning of mechatronics system with various pneumatic, hydraulic and electrical systems.
- CO2 :** Discuss the functioning of control systems with the help of PLC and microcontrollers
- CO3 :** Classify the various types of actuators and sensor systems based on the principle of operation and application
- CO4 :** Explain the working principles of stepper and DC motors
- CO5 :** Analyze the mechatronics circuits using software.

LIST OF EXPERIMENTS:

1. Study of various types of actuators and transducers
2. Study of various types of sensors
3. Study of hydraulic, pneumatic and electro-pneumatic circuits
4. Study of PLC and its applications
5. Assembly language programming of 8085 – Addition – Subtraction – Multiplication- Division – Sorting – Code Conversion.
6. Stepper motor interface
7. Traffic light interface.
8. Speed control of DC motor
9. Modelling and analysis of basic hydraulic, pneumatic and electrical circuits using Software
10. Study of image processing technique

Total Periods: 30

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

Objectives:

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature
- To develop the methodology to solve the identified problem right from its identification and literature review till the successful solution of the same.
- To enable the students on a project involving theoretical and experimental studies.
- To train the students in preparing project reports and to face reviews as well as viva-voce examination

Course Outcomes:

Upon completion of the course, the student will be able to

- CO1 :** Identify a problem in mechanical engineering field through survey.
- CO2 :** Develop methodology to find the optimal solution for the problem.
- CO3 :** Learn and perform methodology using appropriate modern tools for the problem
- CO4 :** Prepare a report containing the details of the various stages of the project

Guidelines for Review and Evaluation:

- The project work can be an innovative improvement of existing system in the mechanical engineering or inter disciplinary areas and shall include modeling, design, experimentation, evaluation, fabrication or analysis.
- For industrial projects, supervisor from the organization will be a co-guide
- Each project work will be carried out by a team of maximum four students
- The topic of the project will be approved by the Head of the Department under the guidance of a faculty member who is familiar in this area of interest.
- The aim of the project work is to deepen comprehension of principles by applying them to a new problem which may be the design, manufacture of a device, experimentation, simulation of mechanical systems.
- The project period allotted shall be utilized by the students to receive directions from the guide, library reading, laboratory work, computer analysis or field work as assigned by the guide.
- The progress of the project is evaluated based on a minimum of three reviews.
- The review committee may be constituted by the Head of the Department.
- Each team of students shall finally produce a comprehensive report in the prescribed format covering background information, literature survey, problem statement, project work details and conclusion.
- The students will be evaluated through a viva-voce examination by a panel of external and internal examiners constituted by the Head of the Department.

Semester 8

Objectives:

- To enable the students to study the evolution of Management, its functions, principles and to learn the application of the principles of Management in an organization

Course Outcomes: Upon completing this course, the students will be able to

- CO1 :** Understand the managerial functions and types of business organizations
- CO2 :** Apply planning tools and techniques in an organization.
- CO3 :** Organize various activities to be performed in an organization.
- CO4 :** Instruct and direct the employees by motivation in order to achieve the results
- CO5 :** Control all the activities related to an organization and gain the basic knowledge in all aspects of management

Unit I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9

Definition of Management – Science or Art – Manager Vs Entrepreneur - types of managers - managerial roles and skills – Evolution of Management – Scientific, human relations, system and contingency approaches – Types of Business organization - Sole proprietorship, partnership, company-public and private sector enterprises - Organization culture and Environment – Current trends and issues in Management

Unit II PLANNING 9

Nature and purpose of planning – planning process – types of planning – objectives – setting objectives – policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process

Unit III ORGANISING 9

Nature and purpose – Formal and informal organization – organization chart – organization structure – types – Line and staff authority – departmentalization – delegation of authority – centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.

Unit IV DIRECTING 9

Foundations of individual and group behaviour – motivation – motivation theories – motivational techniques – job satisfaction – job enrichment – leadership – types and theories of leadership – communication – process of communication – barrier in communication – effective communication – communication and IT.

Unit V CONTROLLING 9

System and process of controlling – budgetary and non-budgetary control techniques – use of computers and IT in Management control – Productivity problems and management – control and performance – direct and preventive control – reporting

Total Periods: 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Tripathy PC and Reddy PN	Principles of Management	Tata Mcgraw Hill New delhi	2005
2	Harold Koontz and Heinz Weihrich	Essentials of Management	Tata Mcgraw Hill New delhi	2009

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Stephen A. Robbins, David A. Decenzo and Mary Coulter	Fundamentals of Management, 7 th Edition,	Pearson Education	2011
2	Robert Kreitner and Mamata Mohapatra	Management	Biztantra	2008
3	Richard Pettinger	<i>Mastering Organizational Behaviour</i>	Macmillan Press, London,	2009
4	Gail Freeman - Bell and Janes Balkwill	<i>Management in Engineering</i> – Principles and Practive	Prentice Hall of India Pvt.Ltd.,	2008

Web URL(s)

1. <https://nptel.ac.in/courses/110/105/110105146/>
2. https://onlinecourses.nptel.ac.in/noc20_mg58/preview
3. <https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-mg58/>

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

U19MEI01	Industrial Practice / In-plant Training	L	T	P	C
		0	0	4	2

Objectives:

- To provide hands-on experience at industry or project site or design office or service sectors where mechanical engineering projects/works are carried out
- To provide industrial exposure in various activities such as production, planning, Quality Assurance, Maintenance, Service, etc

Course Outcomes:

Upon completion of the course, the student will be able to

- CO1 :** Understand the practical applications of theoretical concepts studied in the class rooms.
- CO2 :** Take up any challenging practical problems in industries and find solution by formulating proper methodology
- CO3 :** Demonstrate their practical skills in industries, service centers, project sites and design offices

Guidelines for Review and Evaluation:

- Students have to undergo four-week practical training in Mechanical Engineering related industry / project site/service center/design or planning office of their choice but with the approval of the Head of the Department. At the end of the training, student will submit a report as per the format prescribed by the department.
- This course is mandatory and the student has to pass the course to become eligible for the award of degree. The student shall make a presentation before a committee constituted by the Head of the Department which will assess the student based on the report submitted and the presentation made. Marks and appropriate grades will be assigned as per the regulations.

Objectives:

- To solve the identified problem based on the formulated methodology till to find optimal solution.
- To enable the students on a project involving detailed analytical studies.
- To develop skills in discussing the experimental or test results and make conclusions of the project.

Course Outcomes:

Upon completion of the course, the student will be able to

- CO1 :** Take up any challenging practical problems in industries or research institutions.
- CO2 :** Find optimal solution by formulating proper methodology and manufacturing tools.

Guidelines for the Review and Evaluation:

- The student should continue the phase I work on the selected topic as per the formulated methodology under the same guide/supervisor.
- The progress of the project is evaluated based on a minimum of three reviews.
- The review committee may be constituted by the Head of the Department.
- At the end of the semester, each team of students shall finally produce a comprehensive project report in the prescribed format covering background information, literature survey, problem statement, project work phase-I details and conclusion
- The students will be evaluated through a viva-voce examination by a panel of external and internal examiners constituted by the Head of the Department.

Professional Electives

U19MET50

Design Thinking

L	T	P	C
3	0	0	3

Objectives:

- To enhance innovation activities in students in terms of value creation, speed, and sustainability

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO 1: Appreciate various design process procedure

CO 2: Generate and develop design ideas through different technique.

CO 3: Identify the significance of reverse Engineering to Understand products

CO 4: Understand about Immersion, Analysis and Synthesis.

CO 5: Understand about Ideation and Prototyping

Unit I PROCESS OF DESIGN 9

Introduction – Product Life Cycle - Design Ethics - Design Process - Four Step - Five Step - Twelve Step - creativity and Innovation in Design Process - Design limitation

Unit II GENERATING AND DEVELOPING IDEAS 9

Introduction - Create Thinking - Generating Design Ideas - Lateral Thinking – Analogies – Brainstorming - Mind mapping - National Group Technique – Synthesis - Development of work - Analytical Thinking - Group activities recommended

Unit III REVERSE ENGINEERING 9

Introduction - Reverse Engineering - New Understanding about Products - Reasons for Reverse Engineering - Reverse Engineering Process - Step by Step - Case Studies.

Unit IV STAGES IN DESIGN THINKING-I 9

Immersion: Preliminary immersion, In depth immersion. Analysis and Synthesis: Insight, Affinity diagram, Conceptual Map, Guiding criteria, Empathy map.

Unit V STAGES IN DESIGN THINKING-II 9

Ideation: Brain storming Co-creation workshop - Idea menu- Decision matrix.
Prototyping: Paper prototyping, volumetric model, Staging, Storyboard, Service prototyping- Case studies.

Total Periods 45

S. No	Author (s)	Title of the Book	Publisher	Year of Publications
1	John.R.Karsnitz, Stephen, O'Brien and John P.Hutchinson	Engineering Design, 2nd Edition	Cengage Learning	2013
2	Yousef Haik and Tamer, M .Shahin	Engineering Design Process, 2 nd Edition	Cengage Learning,	2011

1. www.tutor2u.net/business/presentations/.../productlifecycle/default.html
2. https://docs.oracle.com/cd/E11108_02/otn/pdf/.../E11087_01.pdf
3. www.bizfilings.com › Home › Marketing › Product Development
4. <https://www.mindtools.com/brainstm.html>
5. <https://www.quicksprout.com/.../how-to-reverse-engineer-your-competit>
6. www.vertabelo.com/blog/documentation/reverse-engineering

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

U19MET51	Renewable Energy Sources and Systems	L	T	P	C
		3	0	0	3

Objectives:

- To learn about solar radiation and solar thermal system application
- To provide knowledge on fundamentals and sizing of solar photovoltaics.
- To study about the potential and energy conversion process of Wind Energy and Bio Energy.
- To impart fundamental knowledge about Ocean Thermal Energy and Geothermal Energy.
- To provide knowledge about the recent trends in Hydrogen and Fuel Cells.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Understand the solar radiation, and its conversion into heat using solar collectors.
- CO2 :** Explain the working concept of solar photovoltaic system for any isolated applications
- CO3 :** Expose the energy conversion process of wind energy and bio energy.
- CO4 :** Illustrate the fundamentals concepts of ocean thermal energy systems and geothermal thermal energy systems
- CO5 :** Update their knowledge in the field of hydrogen and fuel cells.

Unit I SOLAR THERMAL SYSTEMS 9

Solar radiation spectrum, Radiation measurement, Estimation of average solar radiation, Introduction to solar collectors (liquid flat- Plate collector - Air heater and concentrating collector Solar distillation, Solar drying, Solar thermal system for power generation.

Unit II SOLAR PHOTOVOLTAIC SYSTEMS 9

Operating principle, Photovoltaic cell concepts, Cell, module, array, Voltage current characteristics of a solar cell, Series and parallel connections, Maximum power point tracking, Applications - Battery charging, Pumping, Lighting

Unit III WIND ENERGY AND BIO ENERGY 9

Basic principles of wind energy conversion - classification of wind turbines, Site selection considerations - Merits and demerits of wind energy systems. Biofuels classification, Biomass gasification- Technologies for utilisation of biomass,

Unit IV OCEAN THERMAL ENERGY AND GEOTHERMAL ENERGY 9

Wave energy - Energy from waves, energy potential. Conversion devices. Tidal energy – energy potential, conversion systems. Ocean thermal energy conversion -Methodology, Applications. Geothermal energy - classification of geothermal resources.

Unit V HYDROGEN AND FUEL CELLS 9

Basic properties of hydrogen. Technologies of hydrogen production. Transformation of hydrogen energy - Hydrogen economy. Fuel cells - Operating principle, Specific characteristics, advantages and applications.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Rai. G.D.	Non-Conventional Energy Sources	Khanna Publishers, New Delhi.	2011
2	Twidell, J.W. and Weir, A.,	Renewable Energy Sources	EFN Spon Ltd., UK	2006

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Godfrey Boyle	Renewable Energy: Power for a Sustainable Future, 3 rd Edition	Oxford University Press, UK	2012
2	Chetan Singh Solanki	Solar Photovoltaics, Fundamentals, Technologies and Applications, 3 rd Edition	PHI Learning Private Limited, New Delhi,	2015
3	Sukhatme, Suhas P., and J. K. Nayak.	Solar energy, 4 th Edition	McGraw-Hill Education,	2017
4	Johnson Gary, L	Wind Energy Systems	Prentice Hall, New York,	1985

Web URL(s)

1. https://onlinecourses.nptel.ac.in/noc19_gell/course
2. <https://nptel.ac.in/courses/103/107/103107157/>
3. <https://nptel.ac.in/courses/121/106/121106014/>
4. <https://nptel.ac.in/courses/108/105/108105058/>

COs	POs												PSOs	
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CO1	3	2	2	1	1	1	3	1	1	1	1	3	2	1
CO2	3	2	2	1	1	1	3	1	1	1	1	3	2	1
CO3	3	2	2	1	1	1	3	1	1	1	1	3	2	1
CO4	3	2	2	1	1	1	3	1	1	1	1	3	2	1
CO5	3	2	2	1	1	1	3	1	1	1	1	3	2	1
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

U19MET52

Power Plant Engineering

L	T	P	C
3	0	0	3

Objectives:

- To impart the knowledge on boilers and steam power plant.
- To learn about the various components associated with steam power plant.
- To study the working of nuclear and hydel power plant.
- To learn about the working of diesel and gas turbine power plant.
- To provide the knowledge on power plants using renewable energy and economics of power plants.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Explain the working principle of steam power plant and boilers.

CO2 : Represent the function of various systems in steam power plant.

CO3 : Indicate the suitable components for nuclear power plants and hydel power plants.

CO4 : Illustrate the working of diesel and gas turbine power plant.

CO5 : Explain the different sources of renewable energy and calculate the economics of power plants

Unit I INTRODUCTION TO POWER PLANTS AND BOILERS 9

Layout of Steam power plant - Components, Selection. Types of Boilers - High pressure and Supercritical boilers - Positive circulation boilers - Fluidized bed boiler - Waste heat recovery boiler- Industrial Standards for boiler. Combined Power Cycles. Comparison and Selection.

Unit II STEAM POWER PLANT 9

Fuel and Ash Handling - Combustion Equipment for burning coal, Mechanical Stokers, Pulveriser, Electrostatic Precipitator, and Mechanical Collectors. Draught -different types. Surface Condenser types. Cooling Towers. Pollution controls.

Unit III NUCLEAR AND HYDEL POWER PLANTS 9

Basics of nuclear fuels - Fission, Fusion Reaction. Layout - Types of Reactors, Pressurized Water Reactor, Boiling Water Reactor, Waste Disposal and safety aspects. Hydro Electric Power Plant – Essential features, classification and operation. Prime mover – types and selection, Draft tubes – types. Selection of Turbines, Governing of Turbines

Unit IV DIESEL AND GAS TURBINE POWER PLANTS 9

Diesel power plants – layout – working, Different systems – Fuel system, lubrication system, Air intake system, Exhaust system, cooling system, Starting system. Gas Turbine Power Plant-Layout, Fuels, Gas Turbine Material, Open and Closed Cycles Reheating, Regeneration and Intercooling.

Unit V OTHER POWER PLANTS AND ECONOMICS OF POWER PLANTS 9

Geo thermal power plant. Ocean thermal energy conversion (OTEC). Tidal power plant. Solar thermal power plant. Wind energy. Fuel Cell power systems. Cost of Electric Energy - Fixed and operating Costs, Economics of load sharing.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	P. K. Nag	Power plant Engineering , 4 th Edition	Tata McGraw Hill, New Delhi	2014
2	R. K. Rajput	Power Plant Engineering, 5 th Edition	Laxmi Publications, Chennai	2016

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	S. C. Arora, S. Domkundwar	A course in Power Plant Engineering	Dhanpatrai & Sons, New Delhi	2016
2	K.K. Ramalingam	Power Plant Engineering	SciTech Publications (India) Private Limited,	2010
3	G. D. Rai	Introduction to Power Plant Technology	Khanna Publishers, New Delhi	2013
4	El Wakil M.M	Power Plant Technology	Tata McGraw Hill, New Delhi	2010
5	Godfrey Boyle	Renewable energy	Open University, Oxford University Press in association with the Open University	2004

Web URL(s)

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2. https://swayam.gov.in/nd1_noc19_me63/..
3. <https://nptel.ac.in/courses/112/103/112103277/>

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

U19MET53	Gas Dynamics and Jet Propulsions	L	T	P	C
	(Use of Gas Tables is permitted)	2	1	0	3

Prerequisites : Engineering Thermodynamics

Objectives:

- To understand the basic difference between incompressible and compressible flow.
- To understand the phenomenon of shock waves and its effect on flow. To gain some basic knowledge about jet propulsion and Rocket Propulsion.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Apply the concept of compressible flows in variable area ducts
- CO2 :** Apply the concept of compressible flows in constant area ducts.
- CO3 :** Examine the effect of compression and expansion waves in compressible flow
- CO4 :** Use the concept of gas dynamics in Jet Propulsion
- CO5 :** Apply the concept of gas dynamics in Space 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

UNIT II FLOW THROUGH DUCTS 9

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – 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 – Applications.

UNIT IV JET PROPULSION 9

Theory of jet propulsion – Thrust equation – Thrust power and propulsive efficiency – Operating principle, cycle analysis and use of stagnation state performance of ram jet, turbojet, turbofan and turbo prop engines.

UNIT V SPACE PROPULSION 9

Types of rocket engines – Propellants-feeding systems – Ignition and combustion – Theory of rocket propulsion – Performance study – Staging – Terminal and characteristic velocity – Applications – space flights.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Anderson, J.D	Modern Compressible flow, 3 rd Edition,	McGraw Hill	2012
2	Yahya, S.M.	Fundamentals of Compressible Flow	New Age International (P) Limited, New Delhi	2002

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Cohen. H, GEC Rogers and Saravanamutto	Gas Turbine Theory	Longman Group Ltd	1980
2	Ganesan. V	Gas Turbines	Tata McGraw Hill, New Delhi	2010
3	Shapiro. A.H	Dynamics and Thermodynamics of Compressible fluid Flow	John wiley, New York	1953
4	Sutton. G.P	Rocket Propulsion Elements	John wiley, New York	2010
5	Zucrow. N.J	Principles of Jet Propulsion and Gas Turbines	John Wiley, New York	2010

Web URLs

1. <https://nptel.ac.in/courses/112/106/112106166/>
2. <https://nptel.ac.in/courses/101/106/101106044/>
3. <https://nptel.ac.in/courses/112/103/112103021/>

COs	POs												PSOs	
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CO1	3	2	1	1					1			1	3	1
CO2	3	2	1	1					1			1	3	1
CO3	3	2	1	1					1			1	3	1
CO4	3	2	1	1					1			1	3	1
CO5	3	2	1	1					1			1	3	1
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

U19MET54	Refrigeration and Air Conditioning	L	T	P	C
		3	0	0	3

Prerequisites : Knowledge of Engineering Thermodynamics

Objectives:

- To understand the underlying principles of operations in different Refrigeration & Air conditioning systems and components.
- To provide knowledge on design aspects of Refrigeration & Air conditioning systems.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Explain the basic concepts of Refrigeration
- CO2 :** Explain the Vapor compression Refrigeration systems and to solve problems.
- CO3 :** Discuss the various types of Refrigeration systems.
- CO4 :** Explain the concepts of Air conditioning
- CO5 :** Calculate load of Air conditioning systems

UNIT I INTRODUCTION 9

Introduction to Refrigeration - Unit of Refrigeration and C.O.P.– Ideal cycles- Refrigerants Desirable properties – Classification - Nomenclature – ODP and GWP.

UNIT II VAPOUR COMPRESSION REFRIGERATION SYSTEM 9

Vapor compression cycle: p-h and T-s diagrams - deviations from theoretical cycle – sub cooling and super heating- effects of condenser and evaporator pressure on COP- multi pressure system - low temperature refrigeration - Cascade systems – problems. Equipments: Type of Compressors, Condensers, Expansion devices, Evaporators.

UNIT III OTHER REFRIGERATION SYSTEMS 9

Working principles of vapour 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 AIR CONDITIONING SYSTEMS 9

Working of summer and winter air conditioning systems, Classifications, Layout of plants, Air distribution system, Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors, Actuators and Safety controls.

UNIT V LOAD ESTIMATION OF AIR CONDITIONG SYSTEM 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 and IAQ principles, effective temperature and chart, calculation of summer and winter air conditioning load

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Arora, C.P	Refrigeration and Air Conditioning, 3rd edition,	McGraw Hill, New Delhi	2010

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Jones W.P	Air conditioning engineering, 5th edition,	Butterworth-Heinemann	2020
2	Roy J. Dossat	Principles of Refrigeration, 4 th edition,	Pearson Education Asia	2009
3	Stoecker, W.F. and Jones J. W	Refrigeration and Air Conditioning, 2 nd Edition	McGraw Hill, New Delhi	1986

Web URL(s)

1. <https://nptel.ac.in/courses/112/105/112105129/>
2. <https://nptel.ac.in/courses/112/107/112107208/>
3. <https://nptel.ac.in/courses/112/105/112105128/>

COs	POs												PSOs	
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CO1	2	1	1	1			2		1			1	2	2
CO2	2	1	1	1			2		1			1	2	2
CO3	2	1	1	1			2		1			1	2	2
CO4	2	1	1	1			2		1			1	2	2
CO5	2	1	1	1			2		1			1	2	2
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

U19MET55	Alternate Fuels for IC Engines	L	T	P	C
		3	0	0	3

Objectives:

- To evaluate the potentials of various alternative fuels for I.C. engines operation
- To develop understanding on production methods of alternative fuels
- To explore further fuel specification and performance requirements for advanced combustion systems.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Introduction to alternative fuels like biofuels – Alcohol , Biodiesel, Biogas
- CO2 :** Compare the properties of various vegetable oil and explain the performance emission and combustion characteristics
- CO3 :** Analyze performance, emission and combustion characteristics of alcohol used in CI and SI engines
- CO4 :** Analyze performance and emission characteristics of hydrogen, biogas and LPG in SI and CI engines
- CO5 :** Analyze environmental effects of combustion of various fuels, suggest modification in their usage.

Unit I **FUELS** **9**

Availability and suitability to piston engines, concept of conventional fuels, potential alternative fuels- ethanol, methanol, hydrogen, LPG, natural gas , producer gas, bio gas and vegetable oils, use in IC engines and merits and demerits of various fuels.

Unit II **VEGETABLE OILS** **9**

Various vegetable oils for engines– structure of vegetable oil– comparison with gasoline and diesel fuel– etherification process– chemical reaction– properties of vegetable oil ester– performance and combustion characteristics of engine using ester as fuel.

Unit III **ALCOHOL FUELS** **9**

Properties as engine fuels- alcohol and gasoline blends- reformed alcohols– use in IC engines– spark assisted diesel engines- surface ignition engines– ignition accelerators– manufacture of alcohol fuels– performance and combustion characteristics in S. I engines

Unit IV **GASEOUS FUELS** **9**

Hydrogen– properties– use in C. I and S.I engines– production methods, producer gas and bio gas– gasification– properties– use in S.I engines, LPG and natural gas– properties– use in S.I and C.I engines. Performance and combustion characteristics S.I and C.I in engine.

Unit V **AVAILABILITY OF FUELS** **9**

Suitability and Future prospects of gaseous fuels in Indian context. Environmental pollution with conventional and alternate fuels, Pollution control methods and packages.

Total Periods 45

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	R.P Sharma & M.L. Mathur,	A Course in Internal Combustion Engines	Danpatrai & Sons	2001
2	Keith Owen and Trevor Eoley	Automotive Fuels Handbook	SAE publications,	1990
3	Richard L.Bechfold	Alternative Fuels Guide Book	SAE International , Warrendale	1997
4	S. Thipse	Alternate Fuels	Jaico Publications	2010
5	V. Ganesan	Internal Combustion Engine	Tata Mc Graw Hill, New Delhi	2012
6	Osamu Hirao and Richard K.Pefley	Present and Future Automotive Fuels	John Wiley and Sons,	1988

Web Url (s)

1. <https://nptel.ac.in/courses/112/103/112103262/>
2. https://nptel.ac.in/content/storage2/courses/112104033/pdf_lecture/lecture39.pdf

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

U19MET56	Hybrid and Electric Vehicles	L	T	P	C
		3	0	0	3

Objectives:

- To illustrate the new generation electric and hybrid vehicles, their operations and controls

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Familiarize the recent development pertaining to energy system
- CO2 :** Understand the recent development in new generation hybrid vehicles.
- CO3 :** Explain hybrid vehicle operation and its control using information technology
- CO4 :** Prepare and maintain proper automated road network.
- CO5 :** Understand the recent technologies in the area of suspension systems, brakes, aerodynamics and safety

Unit I ELECTRIC, HYBRID AND FUEL CELL VEHICLES 9

Layout of Electric vehicle and Hybrid vehicles – Advantages and drawbacks of electric and hybrid vehicles. System components, Electronic control system – Different configurations of Hybrid vehicles. Power split device. High energy and power density batteries – Basics of Fuel cell vehicles.

Unit II NEW GENERATION HYBRID VEHICLES 9

Hybrid Vehicle engines, Stratified charge engines, lean burn engines, low heat rejection engines, hydrogen engines, HCCI engine, VCR engine, surface ignition engines, VVTI engines.

Unit III VEHICLE OPERATION AND CONTROL 9

Computer Control for pollution and noise control and for fuel economy – Transducers and actuators - Information technology for receiving proper information and operation of the vehicle like optimum speed and direction

Unit IV VEHICLE AUTOMATED TRACKS 9

Preparation and maintenance of proper road network - National highway network with automated roads and vehicles - Satellite control of vehicle operation for safe and fast travel, GPS

Unit V SUSPENSION, BRAKES, AERODYNAMICS AND SAFETY 9

Air suspension – Closed loop suspension, compensated suspension, anti-skid braking system, retarders, regenerative braking, safety gauge air bags- crash resistance. Aerodynamics for modern vehicles, safety systems, materials and standards

Total Periods 45

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Iqbal Hussain	Electric & Hybrid Vehicles – Design Fundamentals”, 2 nd Edition,	CRC Press	2011
2	James Larminie	Electric Vehicle Technology Explained	John Wiley & Sons	2003
3	SAE	Advance hybrid vehicle power transmission	SAE Publication	2000
4	SAE	Bosch Hand Book	SAE Publication,	2003
5	Mehrdad Ehsani, Yimin Gao, Ali Emadi	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals	CRC Press	2010
6	Sandeep Dhameja	Electric Vehicle Battery Systems	Newnes	2000

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1. <https://nptel.ac.in/courses/108/106/108106170/>
2. <https://nptel.ac.in/courses/108/103/108103009/>
3. <https://nptel.ac.in/courses/108/102/108102121/>
4. https://onlinecourses.nptel.ac.in/noc20_ee99/preview

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

U19MET57	Hydrogen and Fuel Cell Technology	L	T	P	C
		3	0	0	3

Objectives:

- To study the basic production techniques of Hydrogen.
- To understand the application and economy of Hydrogen.
- To understand the classifications, construction and working of fuel cells.
- To study the design and performance of fuel cell.
- To provide insights into fuel cell applications and its economics.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Analyze the techniques of Hydrogen gas generation and storage.
- CO2 :** Analyze the application and economics of Hydrogen gas production
- CO3 :** Understand the working principle of operations of different types of fuel cells.
- CO4 :** Analyze the design and performance of full cells.
- CO5 :** Apply the fuel cells for domestic, automotive, space craft power generations and evaluate the techno-economics of fuel cells.

Unit I	HYDROGEN- PRODUCTION AND STORAGE	9
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Fossil fuels, electrolysis, thermal decomposition, nuclear, photochemical, photo catalytic, hybrid-Hydrogen Storage - Metal hydrides, chemical hydrides, carbon nano-tubes- sea as the source of Deuterium, methane hydrate etc.,

Unit II HYDROGEN APPLICATIONS AND ECONOMY 9

Hydrogen transmission systems. Applications of Hydrogen. Hydrogen as an alternative fuel in IC engines- Suitability of Hydrogen as a fuel, and techno-economic aspects of fuel cell as energy conversion device- Hydrogen fuel for transport

Unit III FUEL CELLS 9

Introduction and overview, operating principle, polarization curves, components, types of fuel cell-AFC, PAFC, DMFC, PEMFC, low and high temperature fuel cells, fuel cell stacks.

Unit IV FUEL CELL DESIGN AND PERFORMANCE 9

Stoichiometric coefficients and utilization percentages of fuels and oxygen, mass flow rate calculation for fuel and oxygen in single cell and fuel cell stack, total voltage and current for fuel cells in parallel and serial connection, over-potential and polarizations, DMFC operation scheme, general issues-water flooding and water management, polarization in PEMFC

Unit V APPLICATION OF FUEL CELL AND ECONOMICS
9

Fuel cell usage for domestic power systems, large scale power generation, Automobile, Space. Economic and environmental analysis on usage of Hydrogen and Fuel cell. Future trends in fuel cells

Total Periods **45**

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Rebecca L. and Busby,	Hydrogen and Fuel Cells: A Comprehensive Guide,	Penn Well Corporation	2005
2	Bent Sorensen	Hydrogen and Fuel Cells: Emerging Technologies and Applications,	Elsevier	2005
3	Kordesch, K and G. Simader	Fuel Cell and Their Applications	Wiley	1996
4	Gupta R. B	Hydrogen Fuel: Production, Transport and Storage	CRC Press	2008
5	Jeremy Rifkin	The Hydrogen Economy	Penguin Group	2002
6	Hart, A.B and G.J.Womack,	Fuel Cells: Theory and Application	Prentice Hall	1989
7	O'Hayre R.,Cha S.W., Colella W., and Prinz F. B	Fuel cell fundamentals, 3 rd Edition	John Wiley	2008

Web URL(s)

1. <https://nptel.ac.in/courses/103/102/103102015/>
2. <https://nptel.ac.in/content/storage2/courses/121106014/Week11/lecture34.pdf>
3. <https://nptel.ac.in/content/storage2/courses/121106014/Week11/lecture35.pdf>
4. <https://nptel.ac.in/content/storage2/courses/122101001/downloads/lec-23.pdf>

COs	POs												PSOs	
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CO1	3	2	1	1	1		1					1	1	1
CO2	3	2	1	1	1		1					1	1	1
CO3	3	2	1	1	1		1					1	1	1
CO4	3	2	1	1	1		1					1	1	1
CO5	3	2	1	1	1		1					1	1	1
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

U19MET58

Fuels and Combustion

L	T	P	C
3	0	0	3

Objectives:

- To understand the properties of fuels for the design and operation of the I.C engines.
- To impart the knowledge about combustion in spark ignition and compression ignition engines

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Understand the importance, manufacturing methods, testing methods and combustion methodology of automotive fuels
- CO2 :** Explain the various properties of fuels and their testing
- CO3 :** Understand the relationship between combustion and fuel rating.
- CO4 :** Analyze and impart the fundamentals of combustion processes that occur in automobile vehicles.
- CO5 :** Understand the overall concepts combustion analysis in IC engines.

Unit I MANUFACTURE OF FUELS 9

Structure of petroleum, refining process, fuels, thermal cracking, catalytic cracking, polymerization, alkylation, isomerisation, blending, products of refining process.

Unit II PROPERTIES AND TESTING OF FUELS 9

Thermo-chemistry of fuels, properties and testing of fuels, relative density, calorific value, flash point, fire point, distillation, vapour pressure, spontaneous ignition temperature, viscosity, pour point, flammability, ignitability, diesel index, API gravity, aniline point, carbon residue, copper strip corrosion etc.

Unit III COMBUSTION & FUEL RATING 9

SI Engines – flame propagation and mechanism of combustion, normal combustion, knocking, octane rating, fuel requirements. CI Engine, mechanism of combustion, diesel knock, cetane rating, fuel requirements. Additive - mechanism, requirements of an additive, petrol fuel additives and diesel fuel additives – specifications of fuels.

Unit IV COMBUSTION OF FUELS 9

Chemical composition and molecular structure of hydrocarbon fuels. Combustion Stoichiometry of hydrocarbon fuels – Chemical energy and heat of reaction calculations – Chemical equilibrium and adiabatic flame temperature calculation. Theory of SI and CI engine combustion – Flame velocity and area of flame front. Fuel spray characteristics – droplet size, depth of penetration and atomization

Unit V COMBUSTION ANALYSIS IN IC ENGINES 9

Photographic studies of combustion processes – Analysis of Pressure crank angle diagrams in SI and CI engines. Knock study for Pressure crank angle histories. Apparent heat release rate and Wiebe's law analysis for combustion. Calculation of Ignition delay and combustion duration. – Hot wire and laser Doppler anemometry and velocimetry for flow and combustion analysis in IC engines

Total Periods 45

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Brame, J.S.S. and King, J.G.	Fuels : Solids, Liquids, Gaseous	Edward Arnold	1991
2	Francis, W	Fuels and Fuel Technology Vol. I & II,	Pergamon	1995
3	Mathur. M.L., Sharma. R.P.	A course in internal combustion engines	Dhanpatrai publication	2003
4	B.P. Pundir	Engine Combustion and Emission	Narosa Publishing House	2011
5	Ganesan,V	Internal Combustion Engines	Tata McGraw Hill, New Delhi	1994
6	Willard W. Pulkrabek	Engineering Fundamentals of the Internal Combustion Engines, 2 nd Edition	Pearson Prentice Hall	2007

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1. <https://nptel.ac.in/courses/107/106/107106088/>
2. https://nptel.ac.in/content/storage2/courses/105101008/downloads/cete_43.pdf
3. https://nptel.ac.in/content/storage2/courses/112104033/pdf_lecture/lecture39.pdf
4. https://onlinecourses.nptel.ac.in/noc20_de06/preview

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

U19MET59

Welding Technology

L	T	P	C
3	0	0	3

Objectives:

- To understand the basics of welding
- To know about the various types of welding processes
- To understand the construction of various welding machines
- To know about the working of various welding machines
- To learn about weld joints, weldability and testing of weldments.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Understand the construction and working principles of gas and arc welding process

CO2 : Understand the construction and working principles of resistance welding process

CO3 : Understand the construction and working principles of various solid state welding process

CO4 : Understand the construction and working principles of various special welding processes

CO5 : Understand the concepts on weld joint design, weldability and testing of weldments

Unit I GAS AND ARC WELDING PROCESSES 9

Fundamental principles – Air Acetylene welding, Oxyacetylene welding, Carbon arc welding, Shielded metal arc welding, Submerged arc welding, TIG & MIG welding, Plasma arc welding and Electroslag welding processes - advantages, limitations and applications

Unit II RESISTANCE WELDING PROCESSES 9

Spot welding, Seam welding, Projection welding, Resistance Butt welding, Flash Butt welding, Percussion welding and High frequency resistance welding processes - advantages, limitations and applications

Unit III SOLID STATE WELDING PROCESSES 9

Cold welding, Diffusion bonding, Explosive welding, Ultrasonic welding, Friction welding, Forge welding, Roll welding and Hot pressure welding processes - advantages, limitations and applications

Unit IV OTHER WELDING PROCESSES 9

Thermit welding, Atomic hydrogen welding, Electron beam welding, Laser Beam welding, Friction stir welding, Under Water welding, Welding automation in aerospace, nuclear and surface transport vehicles.

Unit V DESIGN OF WELD JOINTS, WELDABILITY AND TESTING OF WELDMENTS 9

Various weld joint designs – Welding defects – causes and remedies - Weldability of Aluminium, Copper, and Stainless steels. Destructive and non-destructive testing of weldments

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Parmer R.S	Welding Engineering and Technology	Khanna Publishers, New Delhi	2008
2	Parmer R.S	Welding Processes and Technology	Khanna Publishers, New Delhi	1992

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Nadkarni S.V.	Modern Arc Welding Technology, 1 st Edition	Oxford and IBH, New Delhi,	2005
2	Davis A.C	The Science and Practice of Welding	Cambridge University Press, Cambridge	1993
3	Tylecote R.F.	The Solid Phase Welding of Metals	Edward Arnold Publishers Ltd. London	2000
4	Schwartz M.M.	Metals Joining Manual	McGraw Hill Higher Education	1979

Web URL(s)

1. <https://nptel.ac.in/courses/112/107/112107090/>
2. <https://nptel.ac.in/courses/112/103/112103263/>
3. <https://nptel.ac.in/courses/113/106/113106087/>

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

U19MET60	Additive Manufacturing	L	T	P	C
		3	0	0	3

Objectives:

- To educate students with fundamental and advanced knowledge in the field of Additive Manufacturing technology and the associated Aerospace, Architecture, Art, Medical and Industrial applications

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Appreciate the importance of computers and modern tools in manufacturing to reduce cost and matching the societal needs.
- CO2 :** Analyze 2D and 3D models using CAD modeling software and integrating with manufacturing systems.
- CO3 :** Understand the various Additive Manufacturing (AM) techniques and apply them to their potential support in design as well as mass customized manufacturing..
- CO4 :** Apply knowledge on latest techniques of manufacturing in their field of career
- CO5 :** Monitor and control shop floor with the aid of computers

UNIT I INTRODUCTION 9

Need - Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM - Classification of AM processes – Benefits – Applications. Software for AM- Case studies.

UNIT II REVERSE ENGINEERING AND CAD MODELING 9

Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wireframe, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation.

UNIT III LIQUID AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS 9

Stereo lithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and application. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications.

UNIT IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS 9

Selective Laser Sintering (SLS): Principle, process, indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications – case Studies, Selective Laser Melting and Electron Beam Melting

UNIT V OTHER ADDITIVE MANUFACTURING SYSTEMS 9

Three-dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, Demerits, Applications and case studies. Shape Deposition Manufacturing (SDM), Ballistic Particle Manufacturing (BPM), Bio Additive Manufacturing.

Total Periods 45

Text Book

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Chua Chee Kai and Leong Kah Fai	Rapid Prototyping: Principles and Applications in Manufacturing	John Wiley and Sons	1997

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Gibson, I., Rosen, D.W. and Stucker, B	Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing	Springer	2010
2	Gebhardt, A	Rapid prototyping	Hanser Gardener Publications	2003
3	Hilton, P.D. and Jacobs, P.F	Rapid Prototyping and Engineering applications: A tool box for prototype development	CRC press	2005

Web URL(s)

1. <https://nptel.ac.in/courses/112/104/112104265/>
2. <https://nptel.ac.in/courses/110/106/110106146/>

COs	POs												PSOs	
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CO1	3	2	2	2	1				1			1	3	2
CO2	3	2	2	2	1				1			1	3	2
CO3	3	2	2	2	1							1	3	2
CO4	3	2	2	2	1				1			1	3	2
CO5	3	2	2	2	1				1			1	3	2
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

U19MET61	Lean Manufacturing	L	T	P	C
		3	0	0	3

Objectives:

- To study the various tools involved in Lean Manufacturing.
- To learn the above tools to implement Lean Manufacturing system in an organization.
- To Understand six sigma techniques
- To study TQM tools and Techniques

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Identify waste in any process, reduce the waste using proper kaizens and other methods
- CO2 :** Improve the productivity of the organization using Lean Manufacturing tools
- CO3 :** Apply TQM tools and techniques for improving productivity of an organization.
- CO4 :** Implement six sigma techniques in efficient way
- CO5 :** Explain the case studies related to Lean Manufacturing for its implementation

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 CELLULAR MANUFACTURING, JIT AND TPM 9

Cellular Manufacturing – Types of Layout, Principles of Cell layout, Implementation. JIT – Principles of JIT and Implementation of Kanban. TPM – Pillars of TPM, Principles and Implementation of TPM.

Unit III SET UP TIME REDUCTION, TQM, 5S AND VSM 9

Set up time reduction – Definition, philosophies and reduction approaches. TQM – Principles and implementation. 5S Principles and implementation - Value stream mapping - Procedure and principles.

Unit IV SIX SIGMA 9

Six Sigma – Definition, statistical considerations, variability reduction, design of experiments – Six Sigma implementation

Unit V CASE STUDIES 9

Various case studies of implementation of lean manufacturing at industries

Total Periods 45

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Ronald G. Askin and Jeffrey B. Goldberg	Design and Analysis of Lean Production Systems	John Wiley & Sons	2003
2	Mikell P. Groover	Automation, Production Systems and CIM	John Wiley & Sons	2000
3	Rother M. and Shook J,	Learning to See: Value Stream Mapping to Add Value and Eliminate Muda	Lean Enterprise Institute, Brookline, MA.	1999

Web URL(s)

1. <https://nptel.ac.in/courses/112/104/112104188/>
2. <https://nptel.ac.in/courses/110/107/110107130/>
3. <https://www.engr.psu.edu/cim/ie450/ie450ho1.pdf>

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	1	2	1	1				1		3	1	2	1
1	1	1	2	1	1				1		3	1	2	1
CO3	1	1	2	1	1				1		3	1	2	1
CO4	1	1	2	1	1				1		3	1	2	1
CO5	1	1	2	1	1				1		3	1	2	1
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

U19MET62	Process Planning and Cost Estimation	L	T	P	C
		3	0	0	3

Objectives:

- To introduce the process planning concepts to make cost estimation for various products after process planning
- To calculate the machining time for various machining operations
- To select the appropriate process, equipment and tools for production of components

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Select the appropriate process, equipment and tools for production of components.

CO2 : Prepare process planning activity chart.

CO3 : Explain the concept of cost estimation and its importance.

CO4 : Compute the job order cost for different type of shop floor.

CO5 : Calculate the machining time for various machining operations.

Unit I INTRODUCTION TO PROCESS PLANNING 9

Introduction- methods of process planning-Drawing interpretation-Material evaluation – steps in process selection-.Production equipment and tooling selection

Unit II PROCESS PLANNING ACTIVITIES 9

Process parameters calculation for various production processes-Selection jigs and fixtures election of quality assurance methods - Set of documents for process planning-Economics of process planning-case studies

Unit III INTRODUCTION TO COST ESTIMATION 9

Importance of costing and estimation –methods of costing-elements of cost estimation –Types of estimates – Estimating procedure- Estimation labor cost, material cost- allocation of over head charges- Calculation of depreciation cost

Unit IV PRODUCTION COST ESTIMATION 9

Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop

Unit V MACHINING TIME CALCULATION 9

Estimation of Machining Time - Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations ,Drilling and Boring - Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	K.C. Jain & L.N. Aggarwal	Production Planning Control and Industrial Management	Khanna Publishers, New Delhi	1990
2	Sinha B.P,	Mechanical Estimating and Costing	Tata-McGraw Hill, New Delhi	1995

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Chitale A.V. and Gupta R.C.,	Product Design and Manufacturing, 2 nd Edition	Prentice Hall India	2002
2	Russell R.S and Tailor B.W,	Operations Management, 4 th Edition	Prentice Hall India	2003
3	Mikell P. Groover	Automation, Production, Systems and Computer Integrated Manufacturing	Pearson Education	2001
4	Ostwalal P.F. and Munez J.,	Manufacturing Processes and systems, 9 th Edition	John Wiley	1998

Web Url(s)

1. <https://nptel.ac.in/courses/112/107/112107238/>
2. <https://nptel.ac.in/courses/110/107/110107141/>
3. https://onlinecourses.nptel.ac.in/noc20_me30/preview
4. <https://nptel.ac.in/courses/112/107/112107142/>
5. <https://nptel.ac.in/courses/112/107/112107292/>
6. <https://nptel.ac.in/courses/112/107/112107143/>

COs	POs												PSOs	
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CO1	3	2	2	2					1		1		2	1
CO2	3	2	2	2					1		1		2	1
CO3	3	2	2	2					1		1		2	1
CO4	3	2	2	2					1		1		2	1
CO5	3	2	2	2					1		1		2	1
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

U19MET63	Automated Manufacturing Systems	L	T	P	C
		3	0	0	3

Objectives:

- To understand the application of computers in various aspects of automated manufacturing viz., design, process planning, manufacturing, cost estimation, layout and material handling systems.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Explain the basic concepts of CAD, CAM and computer integrated manufacturing systems
- CO2 :** Summarize the production planning, computerized process planning and control
- CO3 :** Differentiate the different coding systems used in group technology
- CO4 :** Explain the concepts of flexible manufacturing system (FMS) and automated guided vehicle (AGV) system
- CO5 :** Classify the robots used in industrial applications

Unit I INTRODUCTION 9

Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM – Concurrent Engineering-CIM concepts – Computerised elements of CIM system – Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In-Time Production.

Unit II COMPUTERISED PROCESS PLANNING AND CONTROL 9

Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control-Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) - Simple Problems.

Unit III CELLULAR MANUFACTURING 9

Group Technology(GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Simple Problems

Unit IV FLEXIBLE MANUFACTURING SYSTEM AND AUTOMATED GUIDED VEHICLE SYSTEM 9

Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control – Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety.

Unit V INDUSTRIAL ROBOTICS 9

Robot Anatomy and Related Attributes – Classification of Robots- Robot Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability - Industrial Robot Applications – Robot Part Programming – Robot Accuracy and Repeatability.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Mikell P. Groover	Automation, Production, Systems and Computer Integrated Manufacturing	Prentice Hall India	2008
2	Radhakrishnan P, Subramanyan S. and Raju V	CAD/CAM/CIM, 2 nd Edition	New Age International (P) Ltd, New Delhi	2000

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Kant Vajpayee S,	Principles of Computer Integrated Manufacturing	Prentice Hall India	2002
2	Rao. P, N Tewari and T.K. Kundra	Computer Aided Manufacturing	Tata McGraw Hill	2000
3	Gideon Halevi and Roland Weill	Principles of Process Planning – A Logical Approach	Chapman & Hall, London	1995

Web Url(s)

1. <https://nptel.ac.in/courses/112/104/112104289/>
2. https://onlinecourses.nptel.ac.in/noc21_me65/preview
3. https://onlinecourses.swayam2.ac.in/nou21_me05/preview

COs	POs												PSOs	
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CO1	3	2	2	1	2				1			1	2	1
CO2	3	2	2	1	2				1			1	2	1
CO3	3	2	2	1	2				1			1	2	1
CO4	3	2	2	1	2				1			1	2	1
CO5	3	2	2	1	2				1			1	2	1
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

U19MET64

Plastic Engineering

L	T	P	C
3	0	0	3

Objectives:

- To impart knowledge on the basic concepts of polymers and its mechanisms.
- To understand the mechanical and fracture behavior of plastics. .
- To use the appropriate techniques to design Injection Moulding.
- To select the suitable plastics for various industrial and automobile applications.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Illustrate the types of plastics, its properties and mechanical behavior.
- CO2 :** Identify the suitable plastics for designing plastic components
- CO3 :** Design Injection Moulds with thermal and mechanical features for specific applications
- CO4 :** Apply the suitable plastic processing methods to design plastic products
- CO5 :** Analyze the plastics used in industrial and automobile applications

Unit I SELECTION OF PLASTICS

9

Mechanical Properties- Material Selection for Strength – Degradation - Wear Resistance and Frictional Properties- Special Properties - Mechanical Behavior of Plastics- Short term testing -Long term testing - Design Methods for Plastics using deformation data -Thermal stresses and Strains- - Time Temperature Superposition - Fracture behavior - Creep behavior - Impact behavior

Unit II INTRODUCTION TO MOULD DESIGN

9

Types of moulds and dies for various processing methods - Mould and Die Design Concept and Materials. Injection Mould Design - Basics of mould construction - Methodical Mould Design - Design of Feed System, Ejection System - Venting - Design of Cooling system - Mould alignment concepts and De-moulding Techniques.

Unit III INJECTION MOULD DESIGN

9

Manufacturing Considerations - Mould Filling Considerations - Weld line-Shrinkage and Warpage - Cooling and Solidification - Structural design Considerations - Structural Members-Design for Stiffness - Processing Limitations in Product Design

Unit IV COMPRESSION AND TRANSFER MOULD DESIGN

9

Basics of mould construction - Mould design -Positive moulds- Positive moulds with Lands- Multicavity moulds with individual, common Loading Chamber - Moulds with a slide core - Split cavity moulds

Unit V BLOW MOULD DESIGN

9

Materials Selection, Mould Cooling, Clamping Force, Venting, Pinch-off, Head die design, Parison Diameter Calculation, Wall Thickness, Vertical-load strength, Blow ratio, Base pushup, Neck and Shoulder Design, Thread and beads, Bottom Design. Extrusion Die Design - Die geometry, Die Design, Materials and Classification

Total Periods 45

Text / Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	R J Crawford	Plastics Engineering	Butterworth-Heinemann, Oxford	1999
2	R.G.W.Pye	Injection Mould Design	SPE Publication	2000
3	P.S.Cracknell and R.W Dyson	Handbook of Thermoplastics - Injection Mould Design	Chapman & Hall	1993
4	Laszlo Sors and Imre Balazs	Design of Plastics Moulds and Dies	Elsevier, Amsterdam	1989

Web Url(s)

1. <https://nptel.ac.in/courses/112107086/>
2. https://swayam.gov.in/nd1_noc19_me66/preview

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

U19MET65	Maintenance Engineering	L	T	P	C
		3	0	0	3

Objectives:

- To understand the principles, objectives and importance of maintenance adopted in industry for successful progress.
- To introduce different maintenance categories, its merits and types of lubrication.
- To expose the idea of condition monitoring, methods and instruments used for allied measurements.
- To learn about failure analysis and repair methods for few mechanical elements.
- To promote computerization in maintenance and inventory management.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Explain the principles, objectives and importance of maintenance adopted in industry

CO2 : Select the suitable maintenance category and lubrication type.

CO3 : Apply the appropriate methods and instruments for condition monitoring.

CO4 : Analyze the failures of mechanical systems and select suitable repair methods.

CO5 : Utilize computers in maintenance and inventory management.

Unit I PRINCIPLES OF MAINTENANCE PLANNING 9

Basic principles of maintenance planning - Objectives and principles of planned maintenance activity - Importance and benefits of sound maintenance systems - Maintenance organization - Maintenance economics.

Unit II MAINTENANCE CATEGORIES AND LUBRICATION 9

Maintenance categories - Comparative merits of each category - Preventive maintenance, Maintenance schedules, Repair cycle - Total Productive Maintenance - Principles and methods of lubrication.

Unit III CONDITION MONITORING 9

Condition based maintenance - Cost comparison with and without Condition Monitoring - Methods and instruments for condition monitoring - Noise, vibration, wear and temperature measurement.

Unit IV FAILURE ANALYSIS AND REPAIR METHODS 9

Failure analysis - Failures and their development - Role of Non Destructive Testing in failure analysis - Repair methods for bearings, cylinder block, fuel pump, shaft.

Unit V COMPUTER AIDED MAINTENANCE MANAGEMENT 9

Approach towards Computerization in maintenance - computer-aided maintenance management system (CAMMS) - Advantages of CAMMS - spare parts and inventory centre performance reporting.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Srivastava S.K,	Maintenance Engineering	S Chand and Company	2010
2	Mishra R.C, and Pathak K	Maintenance Engineering and Management, 2 nd Edition	Prentice Hall India Learning Pvt. Ltd.	2013

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Keith Mobley R, Lindley R. Higgins and Darrin J. Wikoff	Maintenance Engineering Handbook, 7 th Edition	McGraw-Hill Professional	2008
2	Davies A,	Handbook of Condition Monitoring: Techniques and Methodology	Springer	2012
3	Otegui Jose Luis	Failure Analysis, Fundamentals and Applications in Mechanical Components, 19 th Edition	Springer	2014

Web URL(s)

1. <https://nptel.ac.in/courses/112/105/112105232/>
2. <https://nptel.ac.in/courses/112/105/112105048/>
3. <https://www.digimat.in/nptel/courses/video/112107241/L11.html>

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

U19MET66	Non-Traditional Machining Processes	L	T	P	C
		3	0	0	3

Objectives:

- To acquire a functional understanding of non-traditional manufacturing equipment.
- To Understand the terminology used in non-traditional manufacturing industries.
- To provide knowledge on the classification of non-traditional machining process.
- To know about various process parameters and their influence on performance and their applications.
- To impart knowledge on various energy involved in non-traditional machining process.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Understand the need of Non Traditional Machining Processes and able to classify various processes.
- CO2 :** Recognize the role of mechanical energy in non-traditional machining processes.
- CO3 :** Apply the knowledge on machining electrically conductive material through electrical energy in non-traditional machining processes.
- CO4 :** Understand the concept of machining the hard material using chemical energy and electrochemical energy.
- CO5 :** Familiarity with various thermal energy based nontraditional machining processes.

Unit I UNCONVENTIONAL MACHINING PROCESS 9

Introduction - Need - Classification - Energies employed in the processes - Brief overview of Abrasive jet Machining (AJM), Water jet machining (WJM), Ultrasonic machining (USM), Electric discharge machining (EDM), Electro-chemical machining (ECM), Electron beam machining (EBM), Laser beam machining (LBM), Plasma arc machining (PAM).

Unit II MECHANICAL ENERGY BASED PROCESSES 9

Abrasive Jet Machining, Water Jet Machining, Abrasive water jet machining and Ultrasonic Machining - Working Principles, Equipment, Process parameters, Material removal rate, Applications.

Unit III ELECTRICAL ENERGY BASED PROCESSES 9

Electric Discharge Machining - Working Principles, Equipment, Process Parameters, Material removal rate, Electrode / Tool, Power Circuits, Tool Wear, Dielectric, Flushing, Wire cut EDM - Applications. Micro EDM- Electric discharge grinding and drilling- Electro-stream drilling.

Unit IV CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES 9

Chemical machining - Etchants, Maskants - techniques. Electro-chemical machining – Working principle, Equipment, Process Parameters, Material removal rate, Electrical circuit. Electro-chemical grinding - Electro-chemical deburring - Electro-chemical honing - Applications.

Unit V THERMAL ENERGY BASED PROCESSES 9

Laser Beam machining, Plasma Arc Machining - Principles, Equipment. Electron Beam Machining - Principles, Equipment, Types, Beam control techniques, Material removal rate - Applications.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	P. K. Mishra	Non-Conventional Machining	Narosa Publishing House, New Delhi	2007
2	P. C. Pandey and H.S. Shan	Modern Machining Processes	Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi	2008
3	Joao Paulo Davim	Nontraditional Machining Processes: Research Advances	Springer, New York	2013

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Paul De Garmo, J.T. Black, and Ronald.A. Kohser	Material and Processes in Manufacturing	Prentice Hall of India Pvt. Ltd., New Delhi	2011
2	Vijaya Kumar Jain	Advanced Machining Processes	Allied Publishers Pvt. Ltd., New Delhi	2005
3	Hassan El-Hofy	Advanced Machining Processes: Nontraditional and Hybrid Machining Processes	McGraw-Hill Professional, New Delhi	2005

Web Url(s)

1. <https://nptel.ac.in/courses/112105212/>
2. https://www.me.iitb.ac.in/~ramesh/courses/ME338/non_trad.pdf
3. http://www.nitc.ac.in/dept/me/jagadeesha/mev303/OVERVIEW_OF_NTM_PROCESSES.pdf
4. https://swayam.gov.in/nd1_noc20_me41/preview

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

U19MET67

Supply Chain Management

L	T	P	C
3	0	0	3

Objectives:

- To provide an insight on the fundamentals of supply chain networks, tools and techniques
- To understand routing and scheduling in transportation network
- To know the role of information technology in supply chain management
- To Design supply chain network based on various requirement

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Understand the framework and scope of supply chain networks and functions.

CO2 : Design supply chain network based on various requirements

CO3 : Implement routing and scheduling in transportation network.

CO4 : Solve the problems due to lack of coordination in supply chain and obstacles

CO5 : Explain the role of information technology in supply chain management.

Unit I INTRODUCTION

9

Role of Logistics and Supply chain Management: Scope and Importance- Evolution of Supply Chain - Decision Phases in Supply Chain - Competitive and Supply chain Strategies – Drivers of Supply Chain Performance and Obstacles.

Unit II SUPPLY CHAIN NETWORK DESIGN

9

Role of Distribution in Supply Chain – Factors influencing Distribution network design – Design options for Distribution Network- Distribution Network in Practice-Role of network Design in Supply Chain – Framework for network Decisions

Unit III LOGISTICS IN SUPPLY CHAIN

9

Role of transportation in supply chain – factors affecting transportations decision – Design option for transportation network – Tailored transportation – Routing and scheduling in transportation

Unit IV SOURCING AND COORDINATION IN SUPPLY CHAIN

9

Role of sourcing supply chain- supplier selection assessment and contracts- Design collaboration - sourcing planning and analysis - supply chain co-ordination - Bull whip effect – Effect of lack of coordination in supply chain and obstacles – Building strategic partnerships and trust within a supply chain.

Unit V SUPPLY CHAIN AND INFORMATION TECHNOLOGY

9

The role IT in supply chain- The supply chain IT frame work Customer Relationship Management – Internal supply chain management – supplier relationship management – future of IT in supply chain –E-Business in supply chain

Total Periods 45

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Sunil Chopra, Peter Meindl and Kalra	Supply Chain Management, Strategy, Planning, and operation,	Pearson Education	2010
2	Srinivasan G.S,	Quantitative models in Operations and Supply Chain Management	Prentice Hall India	2010
3	David J.Bloomberg, Stephen Lemay and Joe B.Hanna	Logistics	Prentice Hall India	2002
4	Jeremy F.Shapiro	Modeling the supply chain	Thomson Duxbury	2002
5	James B.Ayers	Handbook of Supply chain management	St. Lucie press	2000

Web Url(s)

1. <https://nptel.ac.in/courses/110/106/110106045/>
2. <https://nptel.ac.in/courses/110/107/110107074/>
3. <https://nptel.ac.in/courses/110/105/110105141/>
4. <https://nptel.ac.in/courses/110/108/110108056/>
5. https://onlinecourses.nptel.ac.in/noc21_mg45/preview

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

U19MET68	Marketing Management	L	T	P	C
		3	0	0	3

Objectives:

- To enable students to deal with newer concepts of marketing concepts like strategic marketing segmentation, pricing, advertisement and strategic formulation.
- To enable a student to take up marketing as a professional career.
- To explore the launch of new product in the market

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Explain the steps involved in marketing process.

CO2 : Enhance the knowledge about Marketer's Practices regarding buying behavior and market segmentation.

CO3 : Understand insights on Advertising, Branding and Retailing.

CO4 : Formulate strategy and marketing planning in an Organization for exhibiting skills required to achieve higher goals.

CO5 : Conduct Marketing Research to explore the launch of new product in the market.

Unit I MARKETING PROCESS 9

Definition, Marketing process, dynamics, needs, wants and demands, marketing concepts, environment, mix, types. Philosophies, selling versus marketing, organizations, industrial versus consumer marketing, consumer goods, industrial goods, product hierarchy

Unit II BUYING BEHAVIOUR AND MARKET SEGMENTATION 9

Cultural, demographic factors, motives, types, buying decisions, segmentation factors - demographic - Psycho graphic and geographic segmentation, process, patterns

Unit III PRODUCT PRICING AND MARKETING RESEARCH 9

Objectives, pricing, decisions and pricing methods, pricing management. Introduction, uses, process of marketing research

Unit IV MARKETING PLANNING AND STRATEGY FORMULATION 9

Components of marketing plan-strategy formulations and the marketing process, implementations, portfolio analysis, BCG, GEC grids

Unit V ADVERTISING, SALES PROMOTION AND DISTRIBUTION 9

Characteristics, impact, goals, types, and sales promotions - point of purchase - unique selling proposition. Characteristics, wholesaling, retailing, channel design, logistics, and modern trends in retailing, Modern Trends, e-Marketing.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Philip Kotler and Keller	Marketing Management, 14 th Edition	Prentice Hall of India,	2012
2	Chandrasekar, K.S.,	Marketing Management Text and Cases, 1 st Edition	Tata McGraw Hill,	2010

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Donald S. Tull and Hawkins	Marketing Research	Prentice Hall of India	1997
2	Philip Kotler and Gary Armstrong	Principles of Marketing	Prentice Hall of India	2000
3	Czinkota and Kotabe	Marketing Management	Thomson learning, Indian Edition	2007

Web URL(s)

1. <https://nptel.ac.in/courses/110/104/110104068/>
2. <https://nptel.ac.in/courses/110/104/110104070/>
3. <https://nptel.ac.in/courses/110/108/110108141/>
4. <https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-mg28/>

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

Objectives:

- To introduce the concepts of work study and ergonomics in industrial operations.
- To give an overview of decision making in manufacturing and service operations

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Implement principles of management in an organization.
- CO2 :** Introduce tools and techniques of motion and time study.
- CO3 :** Analyze various aspects of job evaluation and ergonomics
- CO4 :** Apply appropriate basic analytical techniques related to production planning and control.
- CO5 :** Recognize and apply appropriate basic analytical techniques related to wages and incentives.

Unit I WORK MEASUREMENT AND WORK STUDY 9

Work measurement, Techniques- Production study, Time study, Standard time-Rating factors- Work sampling, Work study, Techniques- Human factors- Work study and productivity-method study, Techniques and procedures- charging Techniques- Motion economy principles- SIMO chart- Ergonomics' and Industrial design.

Unit II PLANT LAYOUT AND MATERIAL HANDLING 9

Plant location, site selection- Plant layout types, need, factors influencing the layout - Tools and techniques for developing layout, process chart, flow diagram, string diagram, Template and Scale models- Layout Planning procedure- Assembly line balancing. Material Handling, scope and importance- Types of material handling systems-factors influencing material handling- methods of material handling

Unit III WORK DESIGN ERGONOMICS, PRODUCTION & PRODUCTIVITY 9

Introduction to work design-Work design-for increased productivity, the work system design. Introduction to job design- Effective job design-Environmental factors, organizational factors & behavioral factors. Ergonomics-Objectives' system approach of ergonomic model-Man-machine system Production and productivity-Definition of production, function and type of production- Definition of productivity- Productivity measurement.

Unit IV PRODUCTION PLANNING AND CONTROL 9

Objectives of PPC- Functions of PPC- Aspects of product development and design- Process Planning- Principles of Standardization, specialization, Simplification-Group Technology- Optimum Batch size- ABC analysis-Value Engineering

Unit V WAGES AND INCENTIVES 9

Wages and salary administration- Meaning principles- Techniques of wage fixation- Job evaluation- Merit rating- Methods of wage payment. Incentive scheme, Types, Advantages and disadvantages- Productivity base incentives, Case Example- Evaluation of incentive scheme.

Total Periods 45

Text Books:

S.No	Authir(s)	Title of the Book	Publisher	Year of Publication
1.	Khanna.O.P	Industrial Engineering and Management	Dhanpat Rai Publications Pvt Ltd	2010
2.	Samuel Eilon	Elements of Production Planning and Control	McMillan and Co., Digitized	2007

Reference Books:

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Kumar.B,	Industrial Engineering and Management 9th edition	Khanna Publishers, New Delhi,	2005
2.	Seetharama L. Narasimhan, Dennis W. Mc Leavey and Peter J.Billington	Production Planning and Inventory Control” , 2nd Edition,	Prentice Hall India	2002
3.	Maynard.H	Industrial Engineering Hand Book	McGraw Hill Book Co., New York,,	2010
4.	Chandler Allen Phillips	Human Factors Engineering	John Wiley and Sons, New York	2000

Web Url(s):

1. <https://nptel.ac.in/courses/112/107/112107238/>
2. <https://nptel.ac.in/courses/110/107/110107141/>
3. https://onlinecourses.nptel.ac.in/noc20_me30/preview
4. <https://nptel.ac.in/courses/112/107/112107142/>
5. <https://nptel.ac.in/courses/112/107/112107292/>
6. <https://nptel.ac.in/courses/112/107/112107143/>

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

U19MET70 Internet of Things for Mechanical Applications	L	T	P	C
	3	0	0	3

Objectives:

- To impart knowledge on state of art IoT architecture and data management
- To learn the applications of Devices and Gateways in IoT technology

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Understand the vision of IoT from a global context
- CO2 :** Determine the Market perspective of IoT.
- CO3 :** Build state of the art architecture in IoT
- CO4 :** Understand the design constraints in the real world
- CO5 :** Apply of IoT in Industrial Automation and Real World Design Constraints

Unit I INTRODUCTION 9

Machine to Machine (M2M) to IoT-The Vision-Introduction, From M2M to IoT, M2M towards IoT-the global context, A use case example, Differing Characteristics.

Unit II IoT STRUCTURE 9

M2M to IoT – A Market Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. **M2M to IoT-An Architectural Overview**– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

Unit III IoT NETWORKING 9

M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management

Unit IV IoT ARCHITECTURE 9

IoT Architecture-State of the Art – Introduction, State of the art, **Architecture Reference Model**- Introduction, Reference Model and architecture, IoT reference Model

Unit V ARCHITECTURE MODELING 9

IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. **Real-World Design Constraints**- Introduction, Technical Design constraints-hardware is popular again, Data representation and visualization, Interaction and remote control. **Industrial Automation**- Service-oriented architecture-based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things, **Commercial Building Automation**- Introduction, Case study: phase one-commercial building automation today, Case study: phase two-commercial building automation in the future

Total Periods 45

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Francis, daCosta Henderson, Byron	Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, 1 st Edition	A press Publications,	2013
2	Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos and David Boyle,	From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, 1 st Edition	Academic Press ,USA	2014
3	Vijay Madiseti and Arshdeep Bahga	Internet of Things : A Hands-on-Approach , 1 st Edition	VPT	2014

Web URL(s)

1. https://onlinecourses.nptel.ac.in/noc20_cs24/preview
2. https://onlinecourses.nptel.ac.in/noc21_cs17/preview
3. <https://nptel.ac.in/courses/106/105/106105166/>
4. <https://nptel.ac.in/courses/108/108/108108098/>
5. <https://books.google.co.in/books?id=JPKGBAAQBAJ&lpg=PA1&pg=PA1#v=onepage&q&f=false>

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

U19MET71	Failure Analysis in Design	L	T	P	C
		3	0	0	3

Objectives:

- To understand the various modes of failure for safe design of mechanical components
- To learn about various types of fracture mechanisms associated with failure of a component.
- To provide basic knowledge about the effects of corrosion in failure.
- To learn about the role of environmental effects in failure of a component.
- To impart the knowledge about various failure analysis tools.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Analyze different modes of failure while designing a mechanical component.
- CO2 :** Explain the material behavior while fracture loading
- CO3 :** Explore the various fracture mechanisms affecting safe design.
- CO4 :** Predict the failure of a component due to corrosion and fatigue.
- CO5 :** Use various failure analysis tools for a safe design of mechanical components.

Unit I MATERIALS AND DESIGN PROCESS 9

Factors affecting the behavior of materials in components – effect of component geometry and shape factors- design for high static strength, stiffness and low toughness materials – material selection process – introduction to two and three dimensional state of stresses - Mohr's circle – hydrostatic stress – Von-Mises shear stress.

Unit II FRACTURE MECHANICS 9

Ductile and brittle fractures – cleavage fractography – factors affecting ductile to brittle fracture transition – fracture mechanics approach to design – energy criterion – stress intensity approach – time dependent crack growth and damage – stress analysis of cracks – stress intensity factors – crack growth instability analysis.

Unit III FATIGUE 9

Statistical nature of fatigue – signal to noise curve – structural feature of fatigue – effect of stress concentration – fracture crack propagation – metallurgical variables on fatigue – designing against fatigue – fatigue of bolted, welded and adhesive joints – fatigue tests – purpose, specimen, procedures and evaluation of test results – crack growth measurement – creep – elevated temperature fatigue – super plasticity.

Unit IV CORROSION AND WEAR FAILURES 9

Types of corrosion – factors influencing corrosion failures – sources, characteristics and analysis of stress corrosion cracking - various types of hydrogen damage failures – corrective and preventive actions – types of wear – lubricated and non lubricated wear – wear on different materials – different methods of wear measurement – role of friction on wear – analysis of wear failures – wear tests – ferrography

Unit V FAILURE ANALYSIS TOOLS 9

Reliability concept and hazard function – application of poisson, exponential and Weibull distribution for reliability – bathtub curve – parallel and series system – failure mode effect analysis – design , types, process and industrial case studies.

Total Periods 45

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	T.L. Anderson	Fracture Mechanics : Fundamentals and applications	CRC Press	2007
2	William T. Becker and Roch J. Shipley	Failure Analysis and Prevention ASM Handbook Vol. II	ASM Metals Park, Ohio, USA	2002
3	Prashant Kumar	Elements of Fracture Mechanics	Wheeler Publishing	1999
4	J.E. Shigley	Mechanical Engineering Design	McGraw Hill	2000
5	F Michael and Ashby	Material Selection in Mechanical Design	Butterworth Heinemann	2004

Web URL(s)

1. <https://nptel.ac.in/courses/112107241/>
2. <https://www.coursera.org/learn/machine-design> 1/

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

U19MET72	Concepts of Engineering Design	L	T	P	C
		3	0	0	3

Objectives:

- To impart knowledge on the concepts of Engineering Design process.
- To learn the different types of tools and techniques involved in creative design process.
- To study environmental, ethical and social issues during innovative design process

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Understand the conceptual development techniques to find solution for a critical design issue.
- CO2 :** Apply embodiment principles to translate the conceptual ideas to engineering design
- CO3 :** Apply environmental, ethical and social issues during innovative design process
- CO4 :** Develop the concepts for product architecture.
- CO5 :** Design and develop innovative engineering products for industrial needs using robust design philosophy.

Unit I INTRODUCTION 9

Innovations in Design, Engineering Design Process, Prescriptive and integrative models of design, Design Review and societal considerations- Need for creativity, Generating creative ideas – the seven Da-Vincian principles, Typology of idea generation activities, Principles of creativity, Creativity and serentipity

Unit II IDENTIFICATION OF CUSTOMER NEEDS 9

Evaluating Customer requirements and survey on customer needs, Conversion of customer needs into technical Specifications, Information sources

Unit III CONCEPT GENERATION AND EVALUATION 9

Creativity and Problem solving, Brainstorming, Theory of Inventive Problem solving (TRIZ), Functional Decomposition of the problem for innovative concept development, Morphological design, Introduction to Axiomatic Design, Concept evaluation and decision making.

Unit IV EMBODIMENT DESIGN 9

Introduction, Product Architecture, Configuration and Parametric design Concepts, Industrial Design.

Unit V DESIGN FOR X 9

Design for Manufacturing, Design for Assembly, Design for Environment, Design for Reliability and Robustness, Introduction to FMEA.

Total Periods 45

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Nigel Cross	Engineering Design Methods	John Wiley	2009
2	George E. Dieter,	Engineering Design	McGraw-Hill	2009
3	Genrich Altshuller	The Innovation Algorithm	Technical Innovation Centre	2011
4	Myer Kurtz	Environmentally Conscious Mechanical Design	John Wiley & Sons Ltd	2007
5	Gopalakrishnan.P.S	Ideas, Creativity and Innovation: Keys to Survival	ICFAI university press	2008
6	Srikant Surya Pala A,	TRIZ: A New Framework for Innovation Concepts and Cases	ICFAI university press	2008

Web URL(s)

1. <https://nptel.ac.in/courses/107/101/107101087/>
2. <https://nptel.ac.in/courses/107/103/107103002/>
3. <https://nptel.ac.in/courses/107/103/107103002/>
4. <https://nptel.ac.in/courses/107/104/107104078/>
5. <https://nptel.ac.in/courses/107/101/107101086/>

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

U19MET73	Computational Fluid Dynamics	L	T	P	C
		3	0	0	3

Prerequisites : Knowledge of Finite Element Analysis

Objectives:

- To introduce Governing Equations of viscous fluid flows.
- To introduce numerical modeling and its role in the field of fluid flow and heat transfer.
- To enable the students to understand the various discretization methods, solution procedures and turbulence modeling.
- To create confidence to solve complex problems in the field of fluid flow and heat transfer by using high speed computers.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Derive the governing equations and boundary conditions for fluid dynamics.

CO2 : Analyze Finite difference and Finite volume methods for Diffusion.

CO3 : Analyze Finite volume method for Convective diffusion.

CO4 : Analyze Flow field problems.

CO5 : Explain and solve the Turbulence models and Mesh generation techniques.

Unit I GOVERNING EQUATIONS AND BOUNDARY CONDITIONS 9

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

Unit II FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION 9

Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – Finite volume formulation for steady state One, Two and Three - dimensional diffusion problems –Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations – Use of Finite Difference and Finite Volume methods.

Unit III FINITE VOLUME METHOD FOR CONVECTION DIFFUSION 9

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law, QUICK Schemes.

Unit IV FLOW FIELD ANALYSIS 9

Finite volume methods -Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms.

Unit V TURBULENCE MODELS AND MESH GENERATION 9

Turbulence models, mixing length model, Two equation (k- ϵ) models – High and low Reynolds number models – Structured Grid generation – Unstructured Grid generation – Mesh refinement – Adaptive mesh – Software tools.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Ghoshdastidar, P.S.	Computer Simulation of flow and heat transfer	Tata McGraw-Hill.	2017
2	Versteeg, H.K., and Malalasekera, W	An Introduction to Computational Fluid Dynamics: The finite volume Method	Pearson Education Ltd	2007

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Anil W. Date	Introduction to Computational Fluid Dynamics	Cambridge University Press	2005
2	Chung, T.J.	Computational Fluid Dynamics	Cambridge University Press	2002
3	Ghoshdastidar P.S.	Heat Transfer	Oxford University Press	2005
4	Muralidhar, K., and Sundararajan, T.,	Computational Fluid Flow and Heat Transfer	Narosa Publishing House, New Delhi	2014
5	Patankar, S.V.	Numerical Heat Transfer and Fluid Flow	Hemisphere Publishing Corporation	2004

Web URL(s)

1. <https://nptel.ac.in/courses/112/105/112105045/>

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

U19MET74	Design of Jigs, Fixture and Press Tool (Use of Approved Design Data Book permitted)	L	T	P	C
		3	0	0	3

Objectives:

- To impart knowledge on location and clamping principles
- To understand the functions and design principles of Jigs and fixtures
- To make known the techniques of press tool technology
- To acquire the knowledge in dies and relevant details
- To develop ability for dealing on site problems associated in shop floor

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Apply the principle of jigs and fixtures in holding work
- CO2 :** Design and develop the work holding process for any operation
- CO3 :** Exhibit the technologies available for ease of pressing operation
- CO4 :** Develop the dies for various bending, forming and drawing operations
- CO5 :** Implement the principles of Jigs and Fixtures in any on field production activities.

Unit I LOCATING AND CLAMPING PRINCIPLES 9

Objectives of tool design- Function and advantages of Jigs and fixtures – Basic elements – principles of location – Locating methods and devices – Redundant Location – Principles of clamping – Mechanical actuation – pneumatic and hydraulic actuation Standard parts – Drill bushes and Jig buttons – Tolerances and materials used

Unit II JIGS AND FIXTURES 9

Design and development of jigs and fixtures for given component- Types of Jigs – Post, Turnover, Channel, latch, box, pot, angular post jigs – Indexing jigs – General principles of milling, Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Modular fixturing systems- Quick change fixtures.

Unit III ELEMENTS OF CUTTING DIES 9

Press Working Terminologies – operations – Types of presses – press accessories – Computation of press capacity – Strip layout – Material Utilization – Shearing action – Clearances – Press Work Materials – Center of pressure- Design of various elements of dies – Die Block – Punch holder, Die set, guide plates – Stops – Strippers – Pilots – Selection of Standard parts – Design and preparation of four standard views of simple blanking, piercing, compound and progressive dies

Unit IV BENDING, FORMING AND DRAWING DIES 9

Difference between bending, forming and drawing – Blank development for above operations – Types of Bending dies – Press capacity – Spring back – knockouts – direct and indirect – pressure pads – Ejectors – Variables affecting Metal flow in drawing operations – draw die inserts – draw beads-ironing – Design and development of bending, forming, drawing reverse re-drawing and combination dies – Blank development for axis- symmetric, rectangular and elliptic parts – Single and double action dies.

Unit V SPECIAL DIES 9

Bulging, Swaging, Embossing, coining, curling, hole flanging, shaving and sizing, assembly, fine Blanking dies – recent trends in tool design- computer Aids for sheet metal forming Analysis – basic introduction - tooling for numerically controlled machines- setup reduction for work holding – Single minute exchange of dies – Poka Yoke - Course should be supplemented with visits to industries.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Joshi, P.H.	Jigs and Fixture	Tata McGraw Hill, New Delhi	2004
2	Joshi, P.H.	Press Tools : Design and Construction	Wheels publishing Co	1996

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Donaldson, Lecain and Goold	Tool Design	Tata McGraw Hill, New Delhi	2000
2	K. Venkataraman,	Design of Jigs Fixtures & Press Tools	Tata McGraw Hill, New Delhi	2000

Web URL(s)

1. <https://nptel.ac.in/content/storage2/courses/112105127/pdf/LM-33.pdf>
2. <https://nptel.ac.in/content/storage2/courses/112105127/pdf/LM-34.pdf>
3. http://www.nitc.ac.in/dept/me/jagadeesha/mev303/CHAPT_INTRODUCTION_TO_JIGS_AND%20FIXTURES.pdf

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

U19MET75	Design for Manufacturing, Assembly and Environment	L	T	P	C
		3	0	0	3

Objectives:

- To create knowledge about the design factors which are influencing the manufacturing process
- To select proper manufacturing process with the environment concerns.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Analyse the design principles for manufacturability

CO2 : Selection of methods for productivity with considerations of factors

CO3 : Analyse the design considerations for machining the components

CO4 : Selection of component design for casting

CO5 : Selection of materials for the design of experiments

UNIT I DESIGN PRINCIPLES FOR MANUFACTURABILITY 9

General design principles for manufacturability – Mechanical properties of material: Tensile properties, Engineering stress-strain, True stress strain, Compression properties, Shear properties, mechanisms selection, evaluation method, process capability – feature tolerances –geometric tolerances – assembly limits –datum features – tolerance stacks.

UNIT II FACTORS INFLUENCING FORM DESIGN 9

Working principle, material, manufacture, design- possible solutions - materials choice - influence of materials on form design - form design of welded members, forgings and castings.

UNIT III MACHINING COMPONENT DESIGN 9

Design features to facilitate machining - drills - milling cutters - keyways - reduction of machined area- simplification by separation - simplification by amalgamation - design for machinability - design for economy - design for clampability - design for accessibility - design for assembly. Recommended materials for machinability, Design recommendations - Design for machining round holes: Introduction, Suitable materials, Design recommendations, Recommended tolerances.

UNIT IV CASTING COMPONENT DESIGN 9

Redesign of castings based on parting line considerations - minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - modifying the design - group technology. Die casting: Introduction to die casting, Applications, Suitable material consideration, General design consideration, Specific design recommendation, Design for powder metal processing: Introduction to powder metal processing, Typical characteristics and applications, Design recommendations.

UNIT V DESIGN FOR ENVIRONMENT 9

Introduction – environmental objectives – global issues – regional and local issues – basic DFE methods – design guidelines – lifecycle assessment method – techniques to reduce environmental impact –design for energy efficiency – design to regulations and standards.

Total Periods 45

Web URL(s)

Objectives:

- To provide the basic concepts of product design, product features and its architecture
- To impart basic knowledge in the common features a product and incorporate them suitably in product.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Design and development some products for the given set of applications
- CO2 :** Make a prototype by utilizing the knowledge gained through prototyping technology
- CO3 :** Establish product architecture by creating detailed interface specifications
- CO4 :** Explain the design process by incorporating CAD, CAM and CAE tools
- CO5 :** Execute the product development activities in economical way.

Unit I INTRODUCTION**9**

Need for IPPD – Strategic importance of Product development – integration of customer, designer, material supplier and process planner, Competitor and customer – Behaviour analysis. Understanding customer – prompting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specifications.

Unit II CONCEPT GENERATION AND SELECTION**9**

Task – Structured approaches – clarification – search – externally and internally – explore systematically – reflect on the solutions and processes – concept selection – methodology – benefits.

Unit III PRODUCT ARCHITECTURE**9**

Implications – Product change – variety – component standardization – product performance – manufacturability – product development management – establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailed interface specifications

Unit IV INDUSTRIAL DESIGN**9**

Integrate process design – Managing costs – Robust design – Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically – Need for industrial design – impact – design process – investigation of for industrial design – impact – design process – investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.

Unit V DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT**9**

Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs – Minimize system complexity – Prototype basics – principles of prototyping – planning for prototypes – Economic Analysis – Understanding and representing tasks – baseline project planning – accelerating the project – project execution

Total Periods 45

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Kari T.Ulrich and Steven D.Eppinger	Product Design and Development	McGraw-Hill International Editions	1999
2	Kemmneth Crow	Concurrent Engineering ./ Integrated Product Development	DRM Associates, 26/3, Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book.	1992
3	Stephen Rosenthal	Effective Product Design and Development	One Orwin, Homewood, , ISBN 1-55623-603-4.	1992
4	Staurt Pugh	Tool Design :Integrated Methods for Successful Product Engineering	Addison Wesley Publishing, New York,	1997

Web URL(s)

1. <https://nptel.ac.in/courses/112/107/112107217/>
2. <https://nptel.ac.in/courses/112/104/112104230/>
3. https://onlinecourses.nptel.ac.in/noc21_me66/preview

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

Total Periods **45**

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Ibrahim Zeid	Mastering CAD CAM	Tata McGraw-Hill Publishing Co.	2007
2	Radhakrishnan P, Subramanyan S. And Raju V	CAD/CAM/CIM	New Age International (P) Ltd, New Delhi	2000

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Chris McMahon and Jimmie Browne	CAD/CAM Principles", "Practice and Manufacturing management “	Pearson Education	1999
2	Donald Hearn and M. Pauline Baker	Computer Graphics	Prentice Hall, Inc	1992
3	Foley, Wan Dam, Feiner and Hughes	Computer graphics principles and Practice	Pearson Education	2003

Web URL(s)

1. <https://nptel.ac.in/courses/112/102/112102101/>
2. <https://nptel.ac.in/courses/112/102/112102102/>
3. <http://www.nptelvideos.in/2012/12/computer-aided-design.html>

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

U19MET78	Micro Electro Mechanical Systems	L	T	P	C
		3	0	0	3

Objectives:

- To impart knowledge of design, fabrication and characterization of Micro Electro Mechanical systems
- To provide basic knowledge of sensors and actuators to fabricate MEMS devices.
- To educate on the rudiments of Micro fabrication techniques.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO 1:** Apply the knowledge of basic science, circuit theory and electro-magnetic field theory in fabricating electro mechanical devices.
- CO 2:** Understand and analyze linear as well as digital electronic circuits
- CO 3:** Explain the different types of sensors and actuators used in MEMS.
- CO 4:** Discuss the different materials used for MEMS applications
- CO 5:** Educate on the applications of MEMS to disciplines beyond Electrical and Mechanical engineering.

Unit I INTRODUCTION 9

Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis – Flexural beam bending- Torsional deflection.

Unit II SENSORS AND ACTUATORS-I 9

Electrostatic sensors – Parallel plate capacitors – Applications – Interdigitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors - Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph - Applications – Magnetic Actuators – Micromagnetic components – Case studies of MEMS in magnetic actuators- Actuation using Shape Memory Alloys

Unit III SENSORS AND ACTUATORS-II 9

Piezoresistive sensors – Piezoresistive sensor materials - Stress analysis of mechanical elements – Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials – General Applications

Unit IV MICROMACHINING 9

Silicon Anisotropic Etching – Anisotropic Wet Etching – Dry Etching of Silicon – Plasma Etching – Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies - Basic surface micro machining processes – Structural and Sacrificial Materials – LIGA Process - Assembly of 3D MEMS – Foundry process.

Unit V POLYMER AND OPTICAL MEMS 9

Polymers in MEMS– Polimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS – Lenses and Mirrors – Actuators for Active Optical MEMS.

Total Periods 45

Text Books

S. No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Chang Liu	Foundations of MEMS	Pearson Education Inc	2006
2	Rai-Choudhury P	MEMS and MOEMS Technology and Applications	PHI Learning Private Limited	2009

Reference Books

S. No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Stephen D Senturia	Microsystem Design	Springer Publication	2000
2	Tai Ran Hsu	MEMS & Micro systems Design and Manufacture	Tata McGraw Hill, New Delhi	2002
3	Thomas M.Adams and Richard A.Layton	Introduction MEMS, Fabrication and Application	Springer Publication	2012
4	Julian w. Gardner, Vijay K. Varadan, Osama O. Awadelkarim	Micro Sensors MEMS and Smart Devices	John Wiley & Son LTD	2002

Web URL(s)

1. <https://nptel.ac.in/courses/117/105/117105082/>
2. <https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ee36/>
3. <http://www.nptelvideos.in/2012/12/mems-microsystems.html>
4. https://onlinecourses.nptel.ac.in/noc20_ee56/preview

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

U19MET79

Composite Materials

L	T	P	C
3	0	0	3

Objectives:

- To understand the fundamentals of composite material
- To learn about the benefits gained when combining different materials into a composite.
- To understand different processing methods, issues, properties and testing methods of different composite materials
- To study different types of laminates
- To study joining methods and analyse failure theories

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1 : Understanding of different material to design composites

CO2 : Study of different techniques to process different types of composites and know the limitations of each process

CO3 : Analyses of mathematical techniques to predict the macroscopic properties of different Laminates

CO4 : Study of different types of laminates and stresses computation

CO5 : Understanding of Joining methods and failure theories

Unit I INTRODUCTION 9

Definition – Composites –Reinforcements and matrices, Types of reinforcements – Types of Matrices – Types of Composites, Carbon Fibre composites - Properties of composites in comparison with standard materials. Applications of metals, ceramics and polymer matrices composites

Unit II MANUFACTURING METHODS 9

Hand and Spray Lay –Up, Injection molding, Resin injections, filament windings , Pultrusion , Castings and Prepregs, Fibre / Matrix Interface , Mechanical measurements of interface strength, Characterization of system; Carbon Fibre / epoxy , Glass Fibre / Polyester etc

Unit III MECHANICAL PROPERTIES - STIFFNESS AND STRENGTH 9

Geometrical aspects – Volume and Weight fraction , Unidirectional continuous fibre – discontinuous fiber, Short fibre system, Woven reinforcements – Mechanical testing; determinations of Stiffness and strength of unidirectional composite, tension , compression , flexure and shear

Unit IV LAMINATES 9

Plate stiffness and Compliance, Assumptions, Strains, Stress Resultants, Computation of stresses , Types of Laminates – Symmetric, Anti symmetric laminates, Balanced laminates, Quasi isotropic laminates, Cross – Ply laminates, Angle ply laminates, Orthotropic laminates, Laminate Moduli, Hydrothermal stresses

Unit V JOINING METHODS AND FAILURE THEORIES 9

Joining – Advantages and Disadvantages of adhesives and Mechanically fastened joints, Typical bond strengths and Test Procedures

Total Periods (L) 45

Text Books

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Mathews F. L. and Rawlings R. D	Composite Materials: Engineering and Science, 1 st Edition	Chapman and Hall, London, England	1994
2	Chawla K. K	Composite materials	Springer – Verlag	1998

Reference Books

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Clyne, T. W. and Withers, P. J	Introduction to Metal Matrix Composites	Cambridge University Press	1993
2	Strong, A.B	Fundamentals of Composite Manufacturing	SME	1989
3	Sharma, S.C	Composite materials	Narosa Publications	2000
4	Brounman, L.J. and Krock,R.M	Modern Composite Materials	Addison-Wesley	1967

Web URL(s)

1. <https://nptel.ac.in/courses/112/104/112104229/>
2. <https://nptel.ac.in/courses/112/104/112104221/>
3. <https://nptel.ac.in/courses/112/104/112104249/>

COs	POs												PSOs	
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CO2	2	2	2	2		2	2					2	3	
CO3	2	2	2	2		2	2					2	3	
CO4	2	2	2	2		2	2					2	3	
CO5	2	2	2	2		2	2					2	3	
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

U19MET80	WIRE ARC ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

Objectives:

- To impart fundamentals of additive manufacturing processes
- To know various file formats, software tools, processes, techniques of AM
- To study fundamental Welding processes for AM
- To study and know about the essential testing required for WAAM component
- To understand Smart manufacturing, Industry 4.0 concepts and Industrial applications of WAAM

Course Outcomes:

At the end of this course, students will learn and enhance the ability to

- CO1 :** Brief the concept of additive manufacturing
- CO2 :** Understand the different welding processes available for additive manufacturing
- CO3 :** Analyze, differentiate and demonstrate the meaning of metal additive manufacturing
- CO4 :** Understand the different material properties to be studied and material characterization
- CO5 :** Explain Environmental and industrial importance of WAAM

Unit I ADDITIVE MANUFACTURING 9

Introduction - Basic Principles of Additive Manufacturing- Additive Manufacturing Processes- Data Sources - Software Tools - File Formats - Designing for Additive Manufacturing – Multiple Materials - Composite Materials - Aerospace, Automotive, Biomedical Applications of AM.

Unit II WELDING PROCESSES FOR ADDITIVE MANUFACTURING 9

Welding – Classification - Gas welding processes- uses - advantages, and limitations - Shielded Metal Arc Welding - Flux-cored Arc Welding - Gas Metal Arc Welding - Gas tungsten arc welding - plasma arc welding - Laser welding

Unit III WELDING BASED ADDITIVE MANUFACTURING 9

Wire Arc AM basics – WAM Process selection - Plasma deposition - TIG/MIG deposition - Laser welding based AM - Laser wire deposition - Electron Beam deposition – Optimization Techniques for WAAM - Distortion control methods - Defects and how to avoid them.

Unit IV TESTING OF COMPONENTS 9

Mechanical properties of metals - Dislocations and strengthening mechanisms – Failure - Grain structure and recrystallization - Development of microstructure and alteration of mechanical properties - Principles of metallographic examinations - Steel/Stainless Steels/Nickel and Aluminium, copper, and other non-ferrous alloys, Titanium - Heat treatments – Corrosion

Unit V INDUSTRIAL RELAVANCE OF WAAM 9

Smart Manufacturing - The Internet of Things – Prototyping – Industry 4.0 – Globalization - The Fourth Revolution - LEAN Production Systems - Cyber-Physical Systems - Next Generation Sensors – Cyber security in Industry 4.0, Basics of Industrial IoT – Advantages – Various real-time applications

Total Periods 45

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	R.S.Parmer	Welding Technology	Khanna Publishers, New Delhi	1992
2	Ramesh Chandra Panda	Industrial People Management	Saliha Publications, New Delhi	2021
3	Nadkarni S.V.	Modern Arc Welding Technology, 1st edition,	Oxford IBH Publishers	2005
4	AWS- Welding Hand Book	Welding Process	AWS- Welding Hand Book	2010
5	Davis A.C.	The Science and Practice of Welding	Cambridge University Press, Cambridge	1993
6	Cunningham, C. R., et al.	Invited review article: Strategies and processes for high quality wire arc additive manufacturing.	Additive Manufacturing	2018

Web URL(s)

1. https://books.google.co.in/books?id=YQC_zRppgcoC

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

U19MET81

HYDRAULICS AND PNEUMATICS

L	T	P	C
3	0	0	3

Objectives:

- To provide student with knowledge on the application of fluid power in process, construction and manufacturing Industries.
- To provide students with an understanding of the fluids and components utilized in modern industrial fluid power system.
- To develop a measurable degree of competence in the design, construction and operation of fluid power circuits.

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1 : Explain the Fluid power and operation of different types of pumps.

CO2 : Summarize the features and functions of Hydraulic motors, actuators and Flow control valves

CO3 : Explain the different types of Hydraulic circuits and systems

CO4 : Explain the working of different pneumatic circuits and systems

CO5 : Summarize the various trouble shooting methods and applications of hydraulic and pneumatic systems

Unit I FLUID POWER PRINCIPLES AND HYDRAULIC PUMPS 9

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps

Unit II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS 9

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols

Unit III HYDRAULIC CIRCUITS AND SYSTEMS 9

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

Unit IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits

Unit V TROUBLE SHOOTING AND APPLICATIONS 9

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs

Total Periods (L) 45

Text Books

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Anthony Esposito	Fluid Power with Applications	Pearson Education	2005
2	Majumdar S.R	Oil Hydraulics Systems- Principles and Maintenance	Tata McGraw Hill	2001

Reference Books

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Anthony Lal	Oil hydraulics in the service of industry	Allied publishers	1982
2	Dudelyt, A. Pease and John T. Pippenger	Basic Fluid Power	Prentice Hall	1987
3	Majumdar S.R	Pneumatic systems – Principles and maintenance	Tata McGraw Hill	1995
4	Michael J, Princhas and Ashby J. G	Power Hydraulics	Prentice Hall	1989
5	Shanmugasundaram.K,	Hydraulic and Pneumatic controls	Chand & Co	2006

Web URL(s)

1. <https://nptel.ac.in/courses/112/106/112106300/>
2. <https://nptel.ac.in/courses/112/105/112105047/>
3. <https://nptel.ac.in/courses/112/105/112105046/>

COs	POs												PSOs	
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CO2	2	1	1	1	-	-	-	-	-	-	-	1	2	1
CO3	2	1	1	1	-	-	-	-	-	-	-		2	1
CO4	2	1	1	1	-	-	-	-	-	-	-	1	2	1
CO5	2	1	1	1	-	-	-	-	-	-	-	1	2	
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

Objectives:

- To develop and strengthen entrepreneurial quality and motivation in students.
- To impart basic entrepreneurial skills and understanding to run a business efficiently and effectively

Course Outcomes: Upon completing this course, the students will be able to

- CO1 :** Identify the role of Entrepreneurship and study factors affecting entrepreneurial growth.
- CO2 :** Apply motivational techniques for effective stress management in entrepreneurship development.
- CO3 :** Gain knowledge and skills needed to run a business successfully.
- CO4 :** Apply knowledge on sources of finance for managing working capital
- CO5 :** Discuss Government policies for small scale enterprises and gain knowledge

Unit I ENTREPRENEURSHIP 9

Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur
Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.

Unit II MOTIVATION 9

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self Rating, Business Games, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.

Unit III BUSINESS 9

Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies

Unit IV FINANCING AND ACCOUNTING 9

Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, Management of working Capital, Costing, Break Even Analysis, Taxation – Income Tax, Excise Duty – Sales Tax.

Unit V SUPPORT TO ENTREPRENEURS 9

Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures - Business Incubators – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting

Total Periods: 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Khanka. S.S.,	Entrepreneurial Development	S.Chand & Co. Ltd., Ram Nagar, New Delhi	2013
2	Donald F Kuratko	Entrepreneuership – Theory, Process and Practice, 9 th Edition	Cengage Learning,	2014

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Hisrich R D, and Peters M P,	Entrepreneurship 8 th Edition	Tata Mc Graw Hill	2018
2	Mathew J Manimala	Enterprenuership theory at cross roads: paradigms and praxis” 2n d Edition	Dream tech	2005
3	Rajeev Roy	Entrepreneurship 2 nd Edition	Oxford University Press	2011

Web URL(s):

1. <https://www.classcentral.com/course/swayam-entrepreneurship-development-19847>
2. https://onlinecourses.swayam2.ac.in/ntr21_ed08/preview
3. <https://nptel.ac.in/>

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

Objectives:

- To impart knowledge about the elements and techniques involved in Mechatronics systems which are very much essential to understand the emerging field of automation

Course Outcomes: Upon completing this course, the students will be able to

- CO1 :** Discuss the interdisciplinary applications of Electronics, Electrical, Mechanical and Computer Systems for the Control of Mechanical and Electronic Systems.
- CO2 :** Classify the actuation and sensor systems based on the principle of operation and application
- CO3 :** Discuss Mechatronic components and systems using the basic building blocks of various systems mathematically, along with different modes of controller.
- CO4 :** Explain the architecture, programming and application of programmable logic controllers to problems and challenges in the areas of Mechatronic engineering.
- CO5 :** Discuss a Mechatronic system using the knowledge and skills acquired through the course and also from the given case studies

Unit I INTRODUCTION 9

Introduction to Mechatronics – Systems – Concepts of Mechatronics approach – 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 MICROPROCESSOR AND MICROCONTROLLER 9

Introduction – Architecture of 8085 – Pin Configuration – Addressing Modes – Instruction set Timing diagram of 8085 – Concepts of 8051 microcontroller – Block diagram.

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 – Basic structure – Input and output processing – Programming – Mnemonics – Timers, counters and internal relays – Data handling – Selection of PLC.

Unit V ACTUATORS AND MECHATRONIC SYSTEM DESIGN 9

Types of Stepper and Servo motors – Construction – Working Principle – Advantages and Disadvantages. Design process-stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Engine Management system – Automatic car park barrier

Total Periods: 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Ramesh S Gaonkar	Microprocessor Architecture, Programming, and Applications with the 8085	Prentice Hall India Ltd	2008
2	Bolton	Mechatronics	Prentice Hall	2008

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Krishna Kant	Microprocessors & Microcontrollers	Prentice Hall India Ltd	2007
2	Devadas Shetty and Richard A. Kolk,	Mechatronics Systems Design	PWS publishing company	2007
3	Clarence W, de Silva	Mechatronics, First Indian Reprint	CRC Press	2012
4	Michael B.Histand and Davis G.Alciatore	Introduction to Mechatronics and Measurement systems International edition	McGraw Hill	2007

Web URL(s):

1. https://onlinecourses.nptel.ac.in/noc21_me27/preview
2. https://onlinecourses.nptel.ac.in/noc21_me129/preview

COs	POs												PSOs	
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CO3	3	2	1	3		2						2	3	2
CO4	3	2	1	3		2						2	3	2
CO5	3	2	1	3		2						2	3	2
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

Objectives:

- To enable the students to create an awareness on Engineering Ethics and Human Values to instill moral and social values, loyalty and to appreciate the rights of others..

Course Outcomes: Upon completing this course, the students will be able to

- CO1 :** Explain human values and their importance in society,
CO2 : Apply engineering ethics in society and use ethical theories.
CO3 : Apply code of ethics and engineering as experimentation
CO4 : Realize the responsibilities, safety and rights in the society.
CO5 : Discuss the global ethical issues related to engineering and

Unit I HUMAN VALUES**9**

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self- confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management

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.

Unit III ENGINEERING AS SOCIAL EXPERIMENTATION**9**

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

Unit IV SAFETY, RESPONSIBILITIES AND RIGHTS**9**

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

Unit V GLOBAL ISSUES**9**

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership – Code of Conduct – Corporate Social Responsibility

Total Periods: 45**Text Books**

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Mike W. Martin and Roland Schinzinger	Ethics in Engineering	Tata McGraw Hill, New Delhi	2003
2	Govindarajan M, Natarajan S, and Senthil Kumar V.S,	Engineering Ethics	Prentice Hall of India, New Delhi,	2004

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Charles B. Fleddermann	Engineering Ethics	Pearson Prentice Hall, New Jersey	2004
2	John R Boatright,	Ethics and the Conduct of Business	Pearson Education, New Delhi	2003
3	Laura P. Hartman and Joe Desjardins	Business Ethics: Decision Making for Personal Integrity and Social Responsibility	Mc Graw Hill education India Pvt. Ltd.,New Delhi	2013
4.	World Community Service Centre	Value Education	Vethathiri publications, Erode	2011

Web URL(s):

1. www.onlineethics.org
2. www.nspe.org
3. www.globalethics.org
4. www.ethics.org

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

Objectives:

- To provide knowledge about various optimization techniques for solving the engineering and business problems.

Course Outcomes: Upon completing this course, the students will be able to

CO1 : Formulate and select the suitable method to solve the linear programming problem

CO2 : Solve the different transportation and assignment-based models.

CO3 : Draw the network models and solve it.

CO4 : Select the suitable queuing model and solve the given applications.

CO5 : Find the total elapsed time and optimum replacement policy.

Unit I LINEAR PROGRAMMING**9**

Operations Research - Introduction, Scope, Objectives, Phases and its limitations. Linear Programming Problem(LPP) Formulation, Graphical method, Simplex method. Artificial variable techniques - Big-M method and two-phase method

Unit II TRANSPORTATION AND ASSIGNMENT MODEL**9**

Transportation - Introduction, Initial basic feasible solutions - Northwest corner rule, Least cost method and Vogel's approximation method. Optimality test using MODI method. Assignment - Introduction and Hungarian method for optimal solution. Travelling salesman problem

Unit III NETWORK MODELS AND PROJECT MANAGEMENT**9**

Network models - Introduction, Rules for construction and errors. Shortest route - Dijkstra's algorithm, Minimal spanning tree - Kruskal's algorithm, Maximum flow models. Project management - CPM and PERT networks.

Unit IV QUEUING MODELS**9**

Queueing model - Introduction , elements, Kendall's Notation, parameters, Single Server and multi-server models, Poisson input, Exponential service, Constant rate service, Finite and Infinite population.

Unit V SEQUENCING AND REPLACEMENT MODEL**9**

Sequencing Problem - Introduction, Types - n jobs with 2 machines and n jobs with 3 machines. Replacement Models - Introduction, Types, Replacement of items that deteriorate with time, Value of money changing with time and not changing with time, Optimum replacement policy - Individual and Group replacement policy

Total Periods: 45**Text Books**

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Taha H.A.,	Operations Research Sixth Edition	Prentice Hall of India	2003
2	Prem Kumar Gupta, D. S. Hira	Introduction to Operations Research	S.Chand and Co	2004

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Frederick S. Hiller, Gerald J. Liberman	Operations Research Concepts and Cases, 8 th edition	Tata McGraw-Hill Publishing Company Private Limited	2010
2	R. Panneerselvam	Operations Research, Second edition	Prentice Hall of India	2010
3	Hamdy A. Taha	Operation Research - An Introduction	Pearson Publications	2010
4.	Wagner	Operations Research	Prentice Hall of India	2000

Web URL(s):

1. https://onlinecourses.swayam2.ac.in/cec20_ma10/preview
2. https://onlinecourses.nptel.ac.in/noc20_ma23/preview
3. https://onlinecourses.nptel.ac.in/noc19_ma29/preview

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

Objectives:

- To sensitize the Engineering students to various aspects of Human Rights.

Course Outcomes: Upon completing this course, the students will be able to

- CO1 :** Explain the meaning of Human Rights and its classification
- CO2 :** Understand the various theories of Human Rights and their background.
- CO3 :** Explain the international laws of Human Rights and monitoring agencies
- CO4 :** Recognize Human Rights in India and its constitutional provisions
- CO5 :** Implement Human Rights in different circumstances.

Unit I INTRODUCTION TO HUMAN RIGHTS 9

Human Rights – Meaning, origin and Development. Notion and classification of Rights – Natural, Moral and Legal Rights. Civil and Political Rights, Economic, Social and Cultural Rights; collective / Solidarity Rights.

Unit II THEORIES OF HUMAN RIGHTS 9

Evolution of the concept of Human Rights Magna carta – Geneva convention of 1864. Universal Declaration of Human Rights, 1948. Theories of Human Rights.

Unit III INTERNATIONAL LAWS 9

Theories and perspectives of UN Laws – UN Agencies to monitor and compliance

Unit IV INDIAN LAWS 9

Human Rights in India – Constitutional Provisions / Guarantees

Unit V IMPLEMENTATION OF HUMAN RIGHTS 9

Human Rights of Disadvantaged People – Women, Children, Displaced persons and Disabled persons, including Aged and HIV Infected People. Implementation of Human Rights – National and State Human Rights Commission – Judiciary – Role of NGO's, Media, Educational Institutions, Social Movements.

Total Periods: 45

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Kapoor S.K.,	“Human Rights under International law and Indian Laws”,	Central Law Agency, Allahabad	2014
2	Chandra U.,	“Human Rights”	Allahabad Law Agency, Allahabad	2014
3	Upendra Baxi	The Future of Human Rights	Oxford University Press, New Delhi	2009

1. https://onlinecourses.swayam2.ac.in/cec20_hs24/preview
2. https://onlinecourses.swayam2.ac.in/cec21_lw07/preview
3. <https://nptel.ac.in/>

1. https://onlinecourses.swayam2.ac.in/cec20_hs24/preview
2. https://onlinecourses.swayam2.ac.in/cec21_lw07/preview
3. <https://nptel.ac.in/>

1. https://onlinecourses.swayam2.ac.in/cec20_hs24/preview
2. https://onlinecourses.swayam2.ac.in/cec21_lw07/preview
3. <https://nptel.ac.in/>

U19MET87	Non-Destructive Testing and Evaluation	L	T	P	C
		3	0	0	3

Objectives:

- To study and understand the various Non Destructive Evaluation and Testing methods, theory and their industrial applications.

Course Outcomes: Upon completing this course, the students will be able to

- CO1 :** Explain the fundamental concepts of NDT
- CO2 :** Discuss the different surface testing methods .
- CO3 :** Explain the concept of Thermography and Eddy current testing
- CO4 :** Explain the concept of Ultrasonic Testing and Acoustic Emission
- CO5 :** Explain the concept of Radiography

Unit I OVERVIEW OF NDT 9

NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT., Visual inspection – Unaided and aided

Unit II SURFACE TESTING METHODS 9

Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

Unit III THERMOGRAPHY AND EDDY CURRENT TESTING 9

Thermography- Principles, Contact and non contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications - .Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation

Unit IV ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION 9

Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique –Principle, AE parameters, Applications

Unit V RADIOGRAPHY 9

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography

Total Periods: 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Baldev Raj, T.Jayakumar, M.Thavasimuthu	Non-Destructive Testing Techniques 1 st Revised Edition	New Age International Publishers	2010
2	Baldev Raj, T.Jayakumar	Practical Non-Destructive Testing	Narosa Publishing House	2010

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Paul E Mix	Introduction to Non-destructive testing: a training guide 2nd Edition	Wiley, New Jersey,	2005
2	Mc Gonnagle	Non-Destructive Testing	McGraw Hill Book Co	2008
3	Barry Hull and Vernon John	Non-Destructive Testing	Macmillan	2009

Web URL(s):

1. https://onlinecourses.nptel.ac.in/noc22_mm13/preview
2. <https://www.digimat.in/nptel/courses/video/113106070/L01.html>
3. <https://nptel.ac.in/>

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

Objectives:

- To familiarize the students with the safety issues in design, handling and industrial environment.

Course Outcomes: Upon completing this course, the students will be able to

- CO1 :** Take suitable preventive measure in industries in order to minimize the accidents.
- CO2 :** Implement safety procedure in material handling industries.
- CO3 :** Implement safety procedure in chemical industries.
- CO4 :** Conduct environmental impact assessment and basic safety inspections using strategies that they have developed.
- CO5 :** Create a document addressing the principles for developing and implementing a successful occupational health and safety program and evaluation of a work site.

Unit I ACCIDENT PREVENTION**9**

Definitions and theories- Accident - Injury - Unsafe act - Unsafe condition - Dangerous occurrence - Theories and principles of accident causation - Cost of accidents - Accident reporting and investigations - Safety committees - Need – Types - Advantages. Safety education and training - Importance - Various training methods - Accident prevention - Motivating factors - Safety suggestion schemes. Definitions connected with measuring safety performance as per Indian and International standards

Unit II SAFETY IN MATERIAL HANDLING**9**

General safety consideration in material handling - Ropes, Chains, Sling, Hoops, Clamps, Arresting gears - Prime movers. Ergonomics consideration in material handling, design, installation, operation and maintenance of conveying equipment, hoisting, traveling and slewing mechanisms. Selection, operation and maintenance of industrial trucks - Mobile cranes - Tower crane

Unit III SAFETY IN CHEMICAL INDUSTRIES**9**

Safety in the design process of chemical plants - Safety in operational and maintenance - Exposure of personnel - Operational activities and hazards - Safety in storage and handling of chemicals and gases - Hazards during transportation - Pipeline transport - Safety in chemical laboratories. Specific safety consideration for cement, paper, pharmaceutical, petroleum, petro - chemical, rubber, fertilizer and distilleries.

Unit IV ENVIRONMENTAL IMPACT ASSESSMENT**9**

Evolution of EIA - Concepts - Methodologies - Screening - Scoping - Checklist – Rapid and Comprehensive EIA - Legislative and environmental clearance procedure in India - Prediction tools for EIA. - Assessment of Impact - Air - Water - Soil - Noise- Biological. Socio cultural environment - Public participation - Resettlement and Rehabilitation. - Documentation of EIA

Unit V REGULATIONS FOR HEALTH, SAFETY AND ENVIRONMENT**9**

Factories act and rules; - Indian explosive act - Gas cylinder rules – Environmental pollution act - Indian petroleum act and rules - Oil industry safety directorate (OISD) - Indian Electricity act and rules. - Mines act and rules - Indian motor vehicles act and rules.

Total Periods: 45**Text Books**

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Handlin.W	Industrial Hand Book	McGraw-Hill	2008
2	Anton.T.J	Occupational safety and health management	McGraw Hill,	2009

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Heinrich.H.W	Industrial Accident Prevention	McGraw Hill,	2000
2	Rudenko.N	Material Handling Equipments	Mir Publishers, Moscow	1991
3	Lees.F.P	Loss “Prevention in Process Industries	Butterworths, NewDelhi	1996
4.	Canter.R.L,	Environmental Impact Assessment	McGraw Hill	2000

Web URL(s):

1. https://onlinecourses.nptel.ac.in/noc20_mg43/preview
2. <https://www.classcentral.com/course/swayam-industrial-safety-engineering-14124>
3. <https://www.edvicer.com/course/industrial-safety-engineering-swayam>

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

Objectives:

- To give an idea about Intellectual Property Rights registration and its enforcement.

Course Outcomes: Upon completing this course, the students will be able to

- CO1 :** Explain the basic concepts of IPR and their importance ,
- CO2 :** Understand the practical aspects of registration of copy rights, trademarks, and patents
- CO3 :** Explain various agreements and Acts related to IPR.
- CO4 :** Discuss the various laws related to intellectual property and digital content protection..
- CO5 :** Understand the enforcement measure to be followed for Infringement of IPRs

Unit I INTRODUCTION**9**

Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

Unit II REGISTRATION**10**

Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad

Unit III AGREEMENTS**10**

International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

Unit IV DIGITAL PRODUCTS AND LAW**9**

Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.

Unit V ENFORCEMENT**7**

Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies

Total Periods: 45**Text Books**

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	V. Scople Vinod	Managing Intellectual Property	Prentice Hall of India, New Delhi,	2012
2	Prabuddha Ganguli	Intellectual Property Rights: Unleashing the Knowledge Economy	McGraw Hill Education	2011

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Dr. R. Radhakrishnan and Dr.S. Balasubramanian	Intellectual Property Rights”,	Excel Books	2018
2	Deborah E. Bouchoux	Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets” Third Edition	Cengage Learning,	2012
3	Neeraj Pandey and ani Dharni Khushdeep	Intellectual Property Rights	Mc Graw Hill Education India Pvt. Ltd. New Delhi	2013
4.	Ramakrishna B and anil Kumar H.S	Fundamentals of Intellectual Property Rights- for students, Industrialist and Patent Lawyers	Notion Press	2017

Web URL(s):

1. https://onlinecourses.nptel.ac.in/noc22_hs59/preview
2. https://onlinecourses.swayam2.ac.in/cec20_hs18/preview
3. <https://nptelswayam.com/nptel/patent-and-intellectual-property-rights%E2%80%8B/>

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

U19MAT04	TRANSFORMS AND BOUNDARY VALUE PROBLEMS	L	T	P	C
	(Common to CIVIL,ECE,EEE,MECH,MCT)	3	1	0	4

Pre-Requisites : Types of integration and differentiation

Objectives:

To make the students to

- Interpret the effective mathematical tools to solve several physical problems by applying the solutions of partial differential equations .
- Demonstrate the methodologies involved in solving many applications in engineering apart from its use in solving boundary value problems
- Exemplify the concepts of Fourier transform.
- Improve the ability in solving applications of partial differential equations.
- Understand the concepts of Z transform techniques for discrete time systems and to solve the difference equations.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Determine types of partial differential equations and to solve it.
2. Explore the geometrical applications of Fourier series.
3. Apply the knowledge of Fourier transform to compute the solution.
4. Explore the basic concepts and solve partial differential equations for application in their field of engineering.
5. Be exposed to the concepts to solve Z transform for application in the field of engineering.

Unit I PARTIAL DIFFERENTIAL EQUATION 12(9+3)

Formation of Partial Differential equation by elimination arbitrary constants and arbitrary functions, Solution of standard types of first order equations, Lagrange's equation, linear partial Differential equation of second and higher order with constant coefficients.

Unit II FOURIER SERIES 12(9+3)

Dirichlet's conditions, General Fourier series, Half Range Sine and Cosine series, Parseval's identity, Harmonic Analysis.

Unit III FOURIER TRANSFORM 12(9+3)

The infinite Fourier transform , sine and cosine transform, properties, inversion theorem, Parseval's identity and convolution theorem (statement only)

Unit IV BOUNDARY VALUE PROBLEMS 12(9+3)

Classification of Second order linear partial differential equations, solutions of one-dimensional wave equation, one-dimensional heat equation ,steady state solution of two dimensional heat equation, Fourier series solution in cartesian coordinates

Unit V Z – TRANSFORMS 12(9+3)

Definition and properties, Elementary Problems, convolution theorem (statement only), Inverse Z transforms (partial fraction method and residue method), Application of Z – Transforms in solving difference equations.

Total Period 60(45+15)

Text/Reference Books:

1. B.S.Grewal (2001). Higher Engineering Mathematics. 42th Edition. Khanna Publishers,Delhi.
2. Srimanta Pal & Subhodh C.Bhunia,"Engineering Mathematics",9th edition ,John Wiley & Sons,2012
3. Bali.N. P and Manish Goyal, "A Textbook of Engineering Mathematics", 7th Edition, Laxmi Publications Pvt Ltd, 2007.
4. E.Kreyszig (2001). Advanced Engineering Mathematics. Tenth Edition. John Wiley and Sons (Asia)Ltd, Singapore.
5. Dennis.G.Zill & Michael .R.Cullen,"Advanced Engineering Mathematics,2nd edition, CBS publishers,2012.

Bloom's Taxonomy Level

K1- Remember (Re), K2 – understand (Un), K3- Apply (Ap), K4- Analyse (An),

K5- Evaluate (Ev), K6 – Create (Cr)

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

Pre-Requisites : None

Objectives:

- To learn about different methods of manufacturing applied in mechanical oriented industries.
- To understand the manufacturing processes in correlation with material properties which change the shape, size and form of the raw materials into the desirable product by conventional
- To explore the different machining processes by unconventional methods
- To learn state of the art manufacturing methods.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Learn the basics of casting and joining technologies, inspection procedures and its relevant codes.
- CO2 :** Understand the plastic deformation processes, load calculation of various deformation processes
- CO3 :** Know the conventional machining processes and its removal mechanism
- CO4 :** Select the appropriate unconventional machining process for specific industrial applications
- CO5 :** Analyze the role of various Additive Manufacturing processes according to industries requirements

Unit I METAL CASTING AND JOINING PROCESSES 9

Concepts of Manufacturing Process -Sand casting -Patterns – Moulding sand– Moulding machines-Core making- Testing- Furnaces – Casting Defects and Inspections; Physics of Welding-various Welding processes-Soldering-Brazing-Plastic welding, Welding defects-NDT Certification -Welding Codes; Adhesive Bonding-semi solid and liquid for Metals and Polymers

Unit II DEFORMATION PROCESSES AND SHEET METAL FORMING 9

Plastic deformation-Yield criteria; Fundamentals of Hot and Cold working processes –Forging-Rolling- Extrusion-Drawing, Load calculations; Formability of Sheet Metal, Shearing, Deep drawing, Bending operations-Super Plastic forming; Introduction to Powder Metallurgy

Unit III CONVENTIONAL MACHINING PROCESSES 9

Orthogonal cutting, Oblique cutting, Chip formation, Mechanism of removal, Merchant and Lee Shaffer Theories, Machinability, Cutting Tools: Single, Multi-Point, Tool Signature, Inserts, Wear, Life, Materials, cutting fluids; Conventional Machining -Turning, Drilling, Milling and finishing processes, Introduction to CNC machining

Unit IV UNCONVENTIONAL MACHINING PROCESSES 9

Abrasive Jet Machining (AJM), Water Jet Machining (WJM), Ultrasonic Machining (UM), Electrochemical Machining (ECM). Electric Discharge Machining (EDM), Laser Beam Machining (LBM), Plasma Arc Machining (PAM), Electron Beam Machining (EBM) - principles, power sources, process parameters, MRR, Surface finish, process capabilities and tooling.

Unit V ADDITIVE MANUFACTURING 9

Fundamentals of Additive Manufacturing (AM)-Product Development-Materials for AM- Stereolithography apparatus - STL file - Fused Deposition Modeling- Laminated Object Manufacturing- Selective Laser sintering- 3D Printer – Tooling.

Total Periods 45

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Rao P.N.	Manufacturing Technology: Foundry, Forming and Welding	Tata McGraw Hill 3rd Edition	2009
2.	Sharma P.C	A Text book of Production Technology	S. Chand and Co. Ltd	2009
3.	Chua C.K., Leong K.F., and Lim C.S	Rapid Prototyping: Principles and Applications	Third Edition, World Scientific Publishers	2010

S.No	Authir(s)	Title of the Book	Publisher	Year of Publication
1.	Mikell P. Groover	Fundamentals of Modern Manufacturing: Materials, Processes, and System	John Wiley and Sons Inc	2010
2.	Steven R. Schmid and Serope Kalpakjian	Manufacturing processes for Engineering Materials	5th Edition, Pearson Education India	2009
3.	Adithan M. and Gupta A.B.	Manufacturing Technology	New Age International Pvt Ltd	2003

1. <https://nptel.ac.in/courses/112107144>

K1- Remember (Re), K2 – understand (Un), K3- Apply (Ap), K4- Analyse (An), K5- Evaluate (Ev), K6 – Create (Cr)

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

Pre-Requisites : Knowledge of Engineering Physics

Note : Use of Standard and approved Steam Table, Mollier Chart, Compressibility Chart and Psychrometric Chart is permitted

Objectives:

- To familiarize the students to understand the fundamentals of thermodynamics
- To perform thermal analysis on their behavior and performance.
- To achieve an understanding of principles of thermodynamics and to be able to use it in accounting for the bulk behaviour of the simple physical systems.
- To enlighten the basic concepts of vapour power cycles
- To understand the working of Air standard cycles

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 Apply the Thermodynamic Principles to Mechanical Engineering Application.

CO2 Apply the first law of thermodynamics for simple open and closed systems under steady and unsteady conditions

CO3 Apply Rankine cycle to steam power plant and compare few cycle improvement methods

CO4 Derive simple thermodynamic relations of ideal and real gases

CO5 Calculate the properties of gas mixtures and moist air and its use in psychometric processes

Unit I BASIC CONCEPTS AND FIRST LAW

10+3

Basic concepts - comparison of microscopic and macroscopic approach. Intensive and extensive, 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, First law of thermodynamics –application to closed and open systems – steady flow processes.

Unit II SECOND LAW AND ENTROPY

10 +3

Zeroth law of thermodynamics – concept of temperature and thermal equilibrium. Heat Reservoir, source and sink. Heat Engine, Refrigerator and Heat pump. Statements of second law and its corollaries. Carnot cycle, Reversed Carnot cycle, Performance. Clausius inequality. Concept of entropy, T-s diagram, entropy change for - pure substance, principle of increase in entropy

Unit III IDEAL AND REAL GASES, THERMODYNAMIC RELATIONS

9 + 3

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.-Generalised Compressibility Chart and its use-Maxwell relations, Tds Equations, Difference and ratio of heat capacities, Energy equation, Joule-Thomson Coefficient, Clausius Clapeyron equation, simple calculations

Unit IV STEAM AND VAPOUR POWER CYCLE

9 + 3

Formation of steam and its thermodynamic properties, T-s, h-s diagrams. Use of Steam Table and Mollier Chart. Determination of dryness fraction. Ideal and actual Rankine cycles, Cycle Improvement Methods - Reheat and Regenerative cycles

Unit V AIR STANDARD CYCLES

7 + 3

Internal combustion (IC) engine - Components and their functions – Working of IC Engine, Otto, Diesel, Dual and Brayton cycles, Calculation of mean effective pressure, and air standard efficiency - Comparison of cycles

Total Periods

60

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Yunus A Cengel , Michael A Boles	Thermodynamics	Tata McGraw – Hill Publishing Company Limited	2014
2.	Natarajan E	Engineering Thermodynamics: Fundamentals Applications and	Anuragam Publications	2012

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Nag P.K	Engineering Thermodynamics	Tata McGraw – Hill Publishing Company Limited	2013
2.	Holman J P	Thermodynamics	McGraw – Hill Publishing Company Limited	1995
3.	Arora C.P	Thermodynamics	Tata McGraw – Hill Publishing Company Limited	2003
4.	Ganesan V	Internal Combustion Engines	Tata McGraw – Hill Publishing Company Limited	2007

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Kothandaraman C.P	Steam Tables, 4th Edition	New Age International	2015

1. <https://nptel.ac.in/courses/112105123/>
2. <http://www.nptel.ac.in/downloads/112108148/>
3. <http://www.freebookcentre.net/Physics/ThermoDynamics-Books.html>

K1- Remember (Re), K2 – understand (Un), K3- Apply (Ap), K4- Analyse (An), K5- Evaluate (Ev), K6 – Create (Cr)

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

U19MEE01	Strength of Materials	L	T	P	C
		2	1	2	4

Pre-Requisites : Knowledge of Engineering Mechanics

Objectives:

- To study and estimate the mechanical properties of materials including its deformations under different loading conditions through experiments.
- To learn two dimensional stress systems and stresses in thin cylinders and spherical shells.
- To understand the deformation of shaft under torsion and deflection of closed helical springs.
- To gain knowledge on shear force and bending stress distribution in different beams under various loads.
- To impart knowledge on finding slope and deflection of beams and buckling of columns for various boundary conditions.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Evaluate the stresses and strains in a regular and composite structures subjected to axial loads.
- CO2 :** Examine the stresses in two dimensional systems, thin cylinders and spheres.
- CO3 :** Examine the stresses induced in shaft and closed coil helical springs subjected to torsion.
- CO4 :** Examine the shear force, bending moment and shear stress of various beams under different loading conditions
- CO5 :** Evaluate the slope and deflection of beams and buckling loads of columns with different boundary conditions.

Unit I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Introduction to mechanical properties - stresses and strains due to axial force, shear force, impact force and thermal stresses - stepped and composite bars - uniformly varying cross section. Stress-strain curve for ductile and brittle materials-Hooke law-Factor of safety –Poisson ratio - Elastic constants and their relationship.

Unit II ANALYSIS OF STRESSES, THIN CYLINDERS AND SPHERES 9

State of stresses at a point-Normal and shear stresses on inclined planes-Principal planes and stresses- Plane of maximum shear stress-Mohr's circle for bi-axial stress with shear stress - Hoop and longitudinal stresses in thin cylindrical and spherical shells-Changes in dimensions and volume.

Unit III TORSION IN SHAFT AND HELICAL SPRING 9

Analysis of torsion of circular solid and hollow shafts-stepped shaft-compound shaft- angle of twist and torsional stiffness. Closed coil helical spring-stresses and deflection under axial load-Maximum shear stress in spring section including Wahl's Factor - applications.

Unit IV LOADS AND STRESSES IN BEAMS 9

Types of beams-Supports and Loads, Shear force and Bending Moment in beams, Cantilever, simply supported and overhanging beams-Point of contra flexure. Theory of simple bending - bending and shear stress - stress variation along the length and section of the beam,

Unit V DEFLECTION OF BEAMS AND COLUMNS 9

Slope and Deflection of cantilever, simply supported and overhanging beams- Double integration method and Macaulay's method. Columns-types-Equivalent length- Euler and Rankine formulae - Slenderness

Total Periods 45

LIST OF EXPERIMENTS:

1. Find the hardness of the material using Rockwell hardness tester.
2. Calculate the hardness of the material using Brinell hardness tester.
3. Calculate the hardness of the material using Vickers hardness tester.
4. Experimental study of an axial bar under tension to obtain the stress strain curve and the strength.
5. Determine the Young-modulus and stiffness of a metal beam through load deflection curve.
6. Experimentally calculate the compressive strength of the materials.
7. Experimental analysis of a bar under torsion to obtain stiffness and angle of twist.
8. Determination of spring constant through load vs deflection curve.
9. Experimentally calculate the strain energy of a material subjected to impact loading

Text Books:

S.No	Authir(s)	Title of the Book	Publisher	Year of Publication
1.	Bansal, R.K.,	Strength of Materials	Laxmi Publications (P) Ltd New Delhi	2007.
2.	Jindal U.C.,	Strength of Materials	Asian Books Pvt. Ltd., New Delhi	2007

Reference Books:

S.No	Authir(s)	Title of the Book	Publisher	Year of Publication
1.	S.S.Rattan	Strength of Materials Second Edition	Tata McGraw Hill, Delhi	2011.
2.	F. P. Beer and R. Johnston	Mechanics of Materials Third edition	Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi,	2002
3.	Egor P. Popov	Engineering Mechanics of Solids	Prentice Hall of India Learning Pvt. Ltd, New Delhi,	2010

Web URL(s):

1. <https://nptel.ac.in/courses/112107146/>
2. https://swayam.gov.in/nd1_noc19_ce18/

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

Pre-Requisites : Knowledge of Engineering Mechanics

Objectives:

- To understand the basic principles involved in fluid mechanics and machinery..
- To learn the behavior of fluid particles under rest and moving conditions.
- To understand the moment principle in fluid mechanics and its application in flow through pumps as well as turbines.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Identify the importance of fluids properties and fluid principles at rest.
- CO2 :** Know the physical behavior of fluids system and equations under moving conditions.
- CO3 :** To apply the concept of dimensional analysis for model study.
- CO4 :** To conduct the performance test on different types of turbines
- CO5 :** To conduct the performance study and selection of pumps for different applications.

Unit I FLUID PROPERTIES

9

Units and Dimensions – Fluid properties – Density, Specific gravity, Viscosity, Surface tension, Capillarity, Compressibility and Bulk modulus – Pascal’s Law – pressure measurements – manometers - Fluid statics - Total pressure and centre of pressure on submerged surfaces

Unit II FLUID KINEMATICS AND DYNAMICS

9

Types of fluid flow and flow lines – control volume – continuity equation in one-dimension and three dimension – velocity potential and stream function -Energy equation – Euler and Bernoulli’s equations – Applications of energy equations- Flow meters - Laminar and Turbulent flow through pipes – Hagen Poissuille equation- Darcy Weisbach formula- applications

Unit III DIMENSIONAL ANALYSIS

9

Need for dimensional analysis – Dimensional Homogeneity – Rayleigh’s and Buckingham methods of dimensional analysis –Problems. Model study and Similitude – scale effects and distorted model.

Unit IV HYDRAULIC TURBINES

9

Classification – construction, working principles and design of Pelton wheel, Francis and Kaplan Turbines - head, losses, work done and efficiency - specific speed – operating characteristics - Governing of Turbines – Problems.

Unit V PUMPS

9

Classification of pumps - Centrifugal pump - working principle - discharge, work done and efficiencies – Gear oil and Multistage pumps - Reciprocating pumps - work done and efficiencies -Problems.

Total Periods 45

LIST OF EXPERIMENTS:

1. Determination of the Coefficient of discharge of given Orifice meter.
2. Determination of the Coefficient of discharge of given Venturi meter.
3. Calculation of the rate of flow using Rota meter.
4. Determination of friction factor for a given set of pipes.
5. Conducting experiments and drawing the characteristic curves of centrifugal pump/ submergible pump
6. Conducting experiments and drawing the characteristic curves of reciprocating pump.
7. Conducting experiments and drawing the characteristic curves of Gear pump.
8. Conducting experiments and drawing the characteristic curves of Pelton wheel.
9. Conducting experiments and drawing the characteristics curves of Francis turbine.
10. Conducting experiments and drawing the characteristic curves of Kaplan turbine.

Text Books:

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Rajput.R.K	A text Book of Fluid Mechanics and Machinery	S. Chand and Company New Delhi	2009
2.	Modi.P.N. and Seth.S.M.,	Hydraulics and Fluid Mechanics including Hydraulic Machines	Standard book house, Delhi	2015
3.	Bansal R K	Fluid Mechanics and Hydraulic Machines	Laxmi Publications New Delhi	2015

Reference Books:

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Streeter, Victor L . and Wylie, E. Benjamin	Fluid Mechanics	Tata McGraw Hill, Delhi	2017
2.	Natarajan.M.K	Fluid Machines	Anuradha Agencies, Vidayal Karuppur, Kumbakonaam	1998
3.	Kumar.K.L	Engineering Fluid Mechanics	Eurasia Publishing House (P) Ltd., New Delhi	2008

Web URL(s):

1. <https://nptel.ac.in/courses/112105206/>

Bloom's Taxonomy Level

K1- Remember (Re), K2 – understand (Un), K3- Apply (Ap), K4- Analyse (An),

K5- Evaluate (Ev), K6 – Create (Cr)

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

Pre-Requisites : Knowledge of Engineering Graphics

Objectives:

- To use limits, fits and tolerances in real world problems.
- To apply different sectional views in drawings .
- To recognize the drawing notations of standard machine elements.
- To familiarize the students with Indian Standards on drawing practices and standard components.
- To draw the detailed drawing of given components.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Examine limits, fits and tolerances in real world problems
- CO2 :** Sketch the sectional views of simple elements.
- CO3 :** Select and draw the standard mechanical elements like bolt, nut, screw, etc
- CO4 :** Draw the assembly drawing of automobile components
- CO5 :** Draw the detailed drawing of automobile components.

Unit I LIMITS, FITS AND TOLERANCES 6

Limit System- Tolerance, Limits, Deviation, Actual Deviation, Upper Deviation, Lower Deviation, Allowance, Basic Size, Design Size, Actual Size. Fits- Types, Tolerances of Form and Position- Form and Position Variation, Geometrical Tolerance, Tolerance Zone, Indicating Geometrical Tolerances. Indication of Surface Roughness, Standard Abbreviations and Symbols used in industries

Unit II SECTIONAL VIEWS 12

Sections- Hatching of Sections, Cutting Planes, Revolved or Removed Section, Sectional Views- Full Section, Half Sections and Auxiliary Sections- Conventional Representation-One view, Two view and Three view Drawings.

Unit III DRAWING OF BASIC MACHINE ELEMENTS 12

Drawing standards and Designation of Bolts, nuts, screws, keys, pins, Rivets, Welded Joints - Dimensioning of Welds, Belt Driven Pulleys, Chain and Gears Drives.

Unit IV ASSEMBLY DRAWINGS 15

Preparation of manual parts drawing and assembled sectional views from orthographic part drawings, Automobile components - stuffing box, Machine Tool Parts - plummer block - knuckle joints - Protected type flanged coupling, - universal coupling - swivel bearing - Preparation of Bill of materials and tolerance data sheet.

Unit V DETAILED MACHINE DRAWINGS 15

Preparation of assembled sectional views from real time products- Internal combustion engine parts - connecting rod, piston - machine tool parts - tailstock, Automobile components - screw jack - stuffing box - Preparation of Bill of materials and tolerance data sheet.

Total Periods 60

Text/Reference Books:

S.No	Authir(s)	Title of the Book	Publisher	Year of Publication
1.	N.D. Bhatt	Machine Drawing	Charotar Publishing House Pvt. Ltd, New Delhi	2014.
2.	Gopalakrishna K R,	Machine Drawing	Subhas Stores, Bangalore	2003

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

Semester 4

U19MAT08	STATISTICS AND NUMERICAL METHODS	L	T	P	C
	(Common to MECH & MCT)	3	1	0	4

Pre-Requisites : Concepts of integration, differentiation and basic of probability and standard distributions

Objectives:

To provide the necessary basic concepts and procedures for solving numerically, different kinds of problems occurring in engineering and technology.

- The roots of nonlinear equations, solutions of large system and problem of matrix can be obtained numerically where analytical methods fail to give solution
- When huge amounts of experimental data are involved, the methods discussed on interpolation will be useful in constructing approximate polynomial to represent the data and to find the intermediate values.
- The numerical differentiation and integration find application when the function in the analytical form is too complicated or the huge amounts of data are given such as series of measurements, observations or some other empirical information.
- Since many physical laws are couched in terms of rate of change of one /two or more independent variables, most of the engineering problems are characterized in the form of either nonlinear ordinary differential equations or partial differential equations. The methods introduced in the solution of ordinary differential equations will be useful in attempting any engineering problems.
- It helps the students to have a clear perception of the power of statistical and numerical techniques, ideas and would be able to demonstrate the applications of these techniques to problems drawn from industry, management and other engineering fields.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Analyze numerical techniques, ideas and would be able to demonstrate the applications of these techniques to problems drawn from industry, management and other engineering fields.
2. Apply the numerical techniques to solve the differentiation and integration.
3. Analyze and solve ordinary differential equations for application in their field of engineering
4. Demonstrate the testing hypothesis in the real life.
5. Explain how to find the solution of industrial and agriculture problems using design of experiments.

Unit I NUMERICAL SOLUTION OF LINEAR EQUATIONS 9+3

Solution of algebraic and transcendental equations– Newton Raphson method - Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Matrix Inversion by Gauss Jordan method.

Unit II INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION 9+3

Interpolation with equal intervals - Newton's forward and backward difference formulae, Interpolation with unequal intervals - Lagrange's interpolation– Approximation of derivatives using interpolation polynomials – Numerical solution of single and double integrations using Trapezoidal and Simpson's rules.

Unit III NUMERICAL SOLUTION OF ODE GIVEN INITIAL VALUES 9+3

Ordinary differential equations: Initial value problems, Taylor series, fourth order Runge - Kutta methods, Predictor Corrector methods, Milne's and Adams Bash forth Method.

Unit IV TESTING OF HYPOTHESIS 9+3

Large sample test based on Normal distribution for single mean and difference of means – Tests based on t,chi-square and F distributions for testing means and variances –Contingency table (Test for Independency) - Goodness of fit.

Unit V DESIGN OF EXPERIMENTS 9+3

One way and two way classifications - Completely randomized design – Randomized block design – Latin square design.

Total Periods 45+15

Text/Reference Books:

1. Grewal. B.S., and Grewal. J.S., "Numerical methods in Engineering and Science", Khanna Publishers, 9th Edition, New Delhi, 2007.
2. Gerald. C. F., and Wheatley. P. O., "Applied Numerical Analysis", Pearson Education, Asia, 6th Edition, New Delhi, 2006.
3. Richard L. Burden, J. Douglas Faires and Annette Burden "Numerical Analysis" , Cengage Learning , 10th edition, 2015.
4. P. Kandasamy, K. Thilagavathy and K. Gunavathy (2005). Numerical Methods. S. Chand & Co. Ltd, Delhi.
5. Douglas. C. Montgomery and George. C. Runger "Applied Statistics and Probability for Engineers" John Wiley and Sons, 5th Edition, 2011.

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

Pre-Requisites : Knowledge of Engineering Mechanics

Objectives:

- To familiarize with various mechanisms and inversions
- To understand the velocity and acceleration of simple mechanisms
- To understand displacement, velocity and acceleration of follower motions of cams.
- To acquaint with basics of power transmission systems by gear trains
- To understand the basic functions of clutches, brakes and belt drives.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Develop and build mechanisms to provide specific motion
- CO2 :** Draw velocity and acceleration diagrams of various mechanisms.
- CO3 :** Draw Cam profile for the specific follower motion
- CO4 :** Select appropriate power transmission for specific application
- CO5 :** Analyze the effects of friction in motion transmission and in machine components

Unit I MECHANISMS

9

Introduction - Links - Pairs - Chain - Mechanism - Machine structure - Degrees of freedom - Four bar chains - Terminology and definition - Planer, Spherical and Spatial Mechanisms - Grashoff's law - Kutzbach criterion - Grubler's criterion for plane mechanism - Inversion of mechanisms - Four bar, single slider crank and double slider crank mechanisms

Unit II KINEMATICS OF MECHANISMS

9

Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method– Velocity and acceleration analysis of Four bar chain and single slider mechanism by relative velocity method and instantaneous centres method– Kennedy's theorem - Coriolis component of Acceleration

Unit III CAMS

9

Types of cams and followers - Follower motion - Uniform, Parabolic, SHM and cycloidal- Displacement diagrams - Cam profiles construction for roller, flat faced and knife edge follower types - Derivatives of Follower motion - circular arc and tangent cams – pressure angle and undercutting in cams.

Unit IV GEARS AND GEAR TRAINS

9

. Gears- Introduction, types= Spur gear terminology and definition – Law of gearing, Construction of Involute and Cycloid gear tooth profile - Gear tooth action – contact ratio – Interference and undercutting in gears - Gear trains: simple, compound, reverted and epicyclic - Velocity ratio and torque calculation in gear trains – Automobile differential.

Unit V FRICTION IN MACHINE ELEMENTS

9

Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads –Bearings and lubrication – Friction clutches – Belt and rope drives – Friction in brakes- Band and Block brakes.

Total Periods 45

LIST OF EXPERIMENTS:

1. Study of gear parameters.
2. Experimental study of velocity ratios of simple gear train.
3. Experimental study of velocity ratios of compound gear train.
4. Experimental study of velocity ratios of epicyclic gear train.
5. Experimental study of velocity ratios of differential gear train.
6. To study Kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker Mechanisms.
7. To study Kinematics of universal joint.
8. To draw cam profile and displacement diagram.
9. To study cam jump phenomenon.

S.No	Authir(s)	Title of the Book	Publisher	Year of Publication
1.	Rattan, S.S	Theory of Machines, 4th Edition	Tata McGraw-Hill	2014.
2.	Dr.R.K.Bansal and Dr.J. S. Brar,	A Text book of Theory of Machines	Laxmi publications, New Delhi	2011

S.No	Authir(s)	Title of the Book	Publisher	Year of Publication
1.	Uicker, J.J., Pennock G.R and Shigley, J.E.,	Theory of Machines and Mechanisms, 4th Edition,	Oxford University Press	2014.
2.	Ghosh. A and Mallick, A.K	Theory of Mechanisms and Machines, 3rd Edition	Affiliated East-West Pvt. Ltd., New Delhi	2006
3.	Thomas Bevan	Theory of Machines, 3rd Edition	CBS Publishers and Distributors	2005
4.	Ambekar A.G.,	Mechanisms and Machine Theory	Prentice Hall of India, New Delhi	2007

1. [nptel.ac.in/courses/Webcourse- contents/.../Kinematics%20of%20Machine/index.html](http://nptel.ac.in/courses/Webcourse-contents/.../Kinematics%20of%20Machine/index.html)
2. nptel.ac.in/courses/112104121/1
3. https://swayam.gov.in/nd1_noc20_me21

K1- Remember (Re), K2 – understand (Un), K3- Apply (Ap), K4- Analyse (An), K5- Evaluate (Ev), K6 – Create (Cr)

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

U19MET06	Engineering Materials and Metallurgy	L	T	P	C
		3	0	0	3

Pre-Requisites : None

Objectives:

- To impart knowledge on the crystal and phase structures of metals/alloys
- To study the heat treatment process employed for various materials
- To learn about metallic and non-metallic materials with their applications
- To impart knowledge on testing and characterising engineering materials
- To gain knowledge about composite and nano materials

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Understand the crystal structure and phase diagrams related to materials.
- CO2 :** Explore the knowledge about various heat treatment processes
- CO3 :** Understand the knowledge about the metallic and non-metallic materials
- CO4 :** Discuss about various material testing methods
- CO5 :** Exhibit the knowledge about the composite and nano materials.

INTRODUCTION AND CRYSTAL STRUCTURE 2

Introduction to material science – classification of Engineering materials – selection of materials – levels of structure. Crystal structure – fundamental concepts – unit cells – crystal systems – SC, BCC, FCC and HCP – structure determination. Crystal defects – grains and grain boundaries – grain size measurement – ASTM grain size number – Metallography – preparation of specimen for micro examination – Metallurgical microscopes.

Unit I PHASE DIAGRAMS AND PHASE TRANSFORMATIONS 9

Phase, Gibbs phase rule, Microstructure, Binary phase diagrams, Isomorphous systems, Conditions of unlimited solubility, Eutectic systems, Intermediate phases, Eutectoid and Peritectic reactions, Iron-Carbon diagram, Microstructures in Iron-Carbon alloys, Phase transformations, Isothermal transformation diagrams, Pearlite, Martensite and Bainite transformations. Continuous Cooling Transformation diagrams.

Unit II HEAT TREATMENT PROCESSES 9

Full, stress relief, recrystallisation and spheroidizing annealing – normalising, hardening and tempering of steel – phase transformation - Isothermal transformation (TTT) diagrams – cooling curves - CCR – CCT diagram - Hardenability, Jominy end quench test - Austempering, martempering – case hardening - carburising, nitriding, cyaniding, carbonitriding, flame and induction hardening - precipitation hardening.8

Unit III METALLIC AND NON-METALLIC MATERIALS 9

Classification, properties, microstructure, processing and applications of plain carbon steels & cast iron – effect of alloying elements on steel (Mn, Si, Cr, Mo, V, Ti & W) - stainless and tool steels - HSLA & maraging steels -Copper and its alloys - Brass, Bronze and Cupronickel – Aluminium and its alloys – Bearing alloys – Nickel and Nickel alloys, Monel metal, Super alloys, Titanium and Titanium alloys, Ceramics, Glasses, Refractories and its types.

Unit IV MECHANICAL TESTING AND CHARACTERISATION 8

Mechanical properties - stress strain curve for ferrous and non-ferrous alloys - Mechanism of plastic deformation, slip and twinning – types of fracture – Griffith theory - testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Rockwell and Vickers) - Impact test (Izod and Charpy) - Fatigue and creep tests - fracture toughness tests - characterisation techniques: Optical, SEM, XRD – Non-Destructive tests.

Unit V COMPOSITE MATERIALS AND NANO MATERIALS 8

Definition–function of matrix and reinforcement in composites–classification of composites based on reinforcement–types of composite materials–polymers, metallic and ceramic matrix composites. Law of mixtures. Comparison with conventional materials. Fabrication of metal matrix and ceramic matrix composites–properties and uses. Nanomaterials: preparation (bottom up and top down approaches), properties and applications – carbon nanotubes: types.

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Raghavan, V.	Materials Science and Engineering : A First course	PHI Learning	2015
2.	Donald R.Askeland, Pradeep P. Fulay and Wendelin J.Wright	Science and Engineering of Materials	Thomson brooks	2010
3.	William D. Callister, Jr.	Material Science and Engineering, Seventh Edition	John Wiley & Sons Inc. New Delhi,	2010

S.No	Authir(s)	Title of the Book	Publisher	Year of Publication
1.	R.Balasubramanian	Callister's Material science and engineering	Wiley India pvt.ltd	2008
2.	Van Vlack	Elements of Material Science And Engineering	Pearson Education India,	2008
3.	Askeland, Fulay, Wright, and Balani	The Science of Engineering and Materials	Cengage learning	2012
4.	Kenneth G Budinski and Michael K Budinski	Engineering Materials: Properties and Selection	PHI learning private limited	2012
5.	Joel R. Fried.	Polymer Science and Technology". 3rd Edition	Prentice Hall	2014

1. www.nptel.iitm.ac.in.
2. www.sciencedaily.co

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

19MEE04	Thermal Engineering	L	T	P	C
		2	1	2	4
Pre-Requisites	: Knowledge of Basic Engineering Thermodynamics				
Note	: Use of standard refrigerant property data book, Steam Tables, Mollier diagram and Psychrometric chart is permitted				
Objectives:					
- To integrate the concepts, laws and methodologies from the first course in thermodynamics into analysis of cyclic processes - To provide in-depth study of thermodynamic principles, thermodynamics of state, basic thermodynamic relations, principle of psychrometry and properties of pure substances - To apply the thermodynamic concepts into various thermal application like IC engines, Steam Turbines, Compressors and Refrigeration and Air conditioning systems.					
Course Outcomes:					
At the end of this course, students will demonstrate the ability to					
CO1	Apply thermodynamic concepts to different air standard cycles and solve problems.				
CO2	Solve problems in single stage and multistage air compressors				
CO3	Explain the functioning and features of IC engines, components and auxiliaries				
CO4	Calculate performance parameters of IC Engines				
CO5	Explain the flow in Gas turbines and solve problems				
Unit I	INTERNAL COMBUSTION ENGINES	10			
Classification - working of four and two stroke engines - SI and CI engines – comparisons- Valve timing diagram and port timing diagram – Performance parameters and calculations and heat balance sheet.					
Unit II	STEAM NOZZLES AND TURBINES	9			
Flow of steam through nozzles, shapes of nozzles, effect of friction, critical pressure ratio, classification of steam turbine, compounding, velocity diagram for simple and multi-stage turbines (Description only)					
Unit III	AIR COMPRESSOR	8			
Classification and working principle of various types of compressors, work of compression with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency of reciprocating compressors, Multistage air compressor and inter cooling –work of multistage air compressor (Description only)					
Unit IV	PSYCHROMETRY	9			
Psychrometric properties, Psychrometric charts. Property calculations of air vapour mixtures by using chart - Psychrometric process – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing. Simple Applications					
Unit V	REFRIGERATION AND AIR CONITIONING	9			
Refrigerants – Vapour compression refrigeration cycle – super heat, sub cooling – Performance calculation – Working principle of vapour absorption system, Ammonia-water, Lithium bromide-water system (Description only) – Air conditioning system –Types and Working principles					
Total Periods		45			

LIST OF EXPERIMENTS:

1. Valve Timing and Port Timing diagrams.
2. Actual P-v diagrams of IC engines.
3. Performance Test on 4 – stroke Diesel Engine.
4. Heat Balance Test on 4 – stroke Diesel Engine.
5. Retardation Test on a Diesel Engine.
6. Determination of Flash Point and Fire Point of various fuels / lubricants.
7. Determination of COP of a refrigeration system
8. Performance test on a reciprocating air compressor
9. Experiments on Psychrometric processes
10. Study on Steam Generators and Turbines

Text Books:

S.No	Authir(s)	Title of the Book	Publisher	Year of Publication
1.	Rajput R.K	Thermal Engineering	S.Chand Publishers	2000
2.	Kothandaraman C P, Domkundwar S , Domkundwar A.V	A Course in Thermal Engineering	Dhanpat Rai & Sons	2002

Reference Books:

S.No	Authir(s)	Title of the Book	Publisher	Year of Publication
1.	Sarkar B K	Thermal Engineering	Tata McGraw – Hill Publishing Company Limited	2007
2.	Arora C P	Refrigeration and Air Conditioning	Tata McGraw – Hill Publishing Company Limited	1994
3.	Ganesan V	Internal Combustion Engines	Tata McGraw – Hill Publishing Company Limited	2007
4.	Rudramoorthy R	Thermal Engineering	Tata McGraw – Hill Publishing Company Limited	2003

Web URL(s):

1. <https://nptel.ac.in/courses/112106133/>
2. <https://nptel.ac.in/courses/112/103/112103275/>
3. <https://www.mechanicalgeek.com/thermal-engineering-by-rk-rajpoot-pdf-download/>

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

Pre-Requisites : None

Objectives:

- To understand the concept and basic mechanics of metal cutting process.
- To provide knowledge on the working of standard machine tools such as lathe, shaping, milling, drilling, grinding and broaching machine tools for manufacturing of various components.
- To understand the basic concepts of Computer Numerical Control (CNC) of machine tools and CNC Programming

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Explain the mechanism of material removal processes
- CO2 :** Describe the constructional and operational features of centre lathe, other special purpose lathes, shaper and planer machines.
- CO3 :** Describe the constructional and operational features of milling, drilling and gear cutting machines
- CO4 :** Explain the grinding and other super finishing processes.
- CO5 :** Summarize numerical control of machine tools and write a part program.

Unit I TURNING AND DRILLING MACHINES 9

Capstan and turret lathes – construction - indexing mechanism - operations - working principle of single and multi - spindle automats - Drilling –reaming – boring - Tapping

Unit II SHAPING AND PLANING MACHINES 9

Shaping and planing machines – types – construction - mechanism – principle of operation – different shaping operations.

Unit III MILLING AND GEAR CUTTING MACHINES 9

Milling operations-types of milling cutter. Gear cutting – forming and generation principle and construction of gear milling ,hobbing and gear shaping processes –finishing of gears

Unit IV ABRASIVE PROCESS AND BROACHING 9

Abrasive processes: grinding wheel – specifications and selection, types of grinding process– cylindrical grinding, surface grinding, centreless grinding and internal grinding- Typical applications – concepts of surface integrity, broaching machines: broach construction – push, pull, surface and continuous broaching machines

Unit V CNC MACHINING 9

Numerical Control (NC) machine tools – CNC types, constructional details, special features, machining centre, part programming fundamentals CNC – manual part programming – micromachining – wafer machining.

Total Periods 45

Text Books:

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Hajra Chowdary, S.K., and Hajra Chowdary, A.K.,	Elements of Workshop Technology Vol.II.,	Asia Publishing House, Bombay	2003
2.	Rao. P.N	Manufacturing Technology - Metal Cutting and Machine Tools, 3 rd Edition	Tata McGraw-Hill, New Delhi	2013

Reference Books:

S.No	Authir(s)	Title of the Book	Publisher	Year of Publication
1.	Jain R.K. and Gupta S.C	Production Technology	Khanna Publishers, New Delhi	1999
2.	HMT	Production Technology	Tata McGraw Hill	1998
3.	Roy. A.Lindberg,	Process and Materials of Manufacture,” Fourth Edition,	PHI/Pearson Education	2006

Web URL(s):

1. https://swayam.gov.in/nd1_noc20_me16/preview
2. https://swayam.gov.in/nd1_noc19_me46/preview
3. <https://nptel.ac.in/courses/112105233/>
4. <https://nptel.ac.in/courses/112105211/>

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

L	T	P	C
0	0	4	2

- Demonstration and study of the various manufacturing processes..
- Study of various General Purpose Machine Tools..
- Study of various Special Purpose Machine Tools.
- Understanding of machine tool capabilities.
- Complete understanding of various grinding and abrasive processes.

At the end of this course, students will demonstrate the ability

CO2 : To gain hands on experience on various manufacturing processes

CO4 : To give a practical hands on exposure in the various machine tools to manufacture Gears

C05 : To evaluate various machine tool cutting parameters

1. Estimation of machining time for Facing, plain turning and step turning
2. Estimation of machining time for Taper turning using compound rest, Tailstock set over, etc
3. Estimation of machining time for Single and Multi-start V thread cutting and knurling.
4. Estimation of machining time for Boring and internal thread cutting.
5. Preparation of Sand Mould with solid pattern.
6. Preparation of Sand Mould with split pattern.
7. Preparation of Sand Mould with Core.
8. Manufacturing of Gear by Gear Milling.
9. Manufacturing of Gear by Gear Hobbing.
10. Two or more exercises in Shaper, Slotter, Planner, Drilling, Milling Machines (example: Round to Square in Shaper, Internal keyway cutting in Slotter, Drilling, Reaming and Tapping using Drilling machine, Keyway milling in Milling machine)
11. Two or More Exercises in Grinding / Abrasive machining (Example: Surface Grinding , Cylindrical Grinding, Centreless Grinding)
12. Measurement of Shear Angle, Cutting Force and Tool Wear

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

U19MTT01	Environmental Science	L	T	P	C
		2	0	0	0

Pre - : Applied Chemistry
Requisites

Objectives:

- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

Course Outcomes:

At the end of this course, the student will be able to

- CO1 :** To study the nature and facts about environment.
- CO2 :** To finding and implementing scientific, technological, economic and political solutions to environmental problems.
- CO3 :** To study the interrelationship between living organism and environment.
- CO4 :** To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- CO5 :** To study the dynamic processes and understand the features of the earth's interior and surface.

Unit I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 5

Definition - scope of environment - concept of an ecosystem - structure and function of an ecosystem - producers, consumers and decomposers - ecological succession processes - Introduction, types, characteristic features, structure and function of the various ecosystems. Introduction to biodiversity - definition: genetic, species and ecosystem diversity - threats to biodiversity - endangered and endemic species of India - conservation of biodiversity: In - situ and ex - situ conservation of biodiversity.

Unit II NATURAL RESOURCES 7

Forest resources: Use and over - exploitation, deforestation, case studies - timber extraction, mining, dams and their effects on forests and tribal people - Water resources: Use and overutilization of surface and ground water - Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies - Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer - pesticide problems, water logging, salinity, case studies - Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

Unit III ENVIRONMENTAL POLLUTION**7**

Definition – Sources, causes, effects and control measures of Water pollution : Physical and chemical properties of terrestrial and marine water and their environmental significance; Water quality parameters - physical, chemical and biological; absorption of heavy metals - Air pollution - Chemical and photochemical reactions in the atmosphere - Control of particulate and gaseous emission, Control of SOX, NOX, CO and HC - Soil pollution - causes, effects and control measures - Marine pollution - Noise pollution - Thermal pollution - Nuclear hazards - role of an individual in prevention of pollution.

Unit IV SOCIAL ISSUES AND THE ENVIRONMENTAL LEGISLATION**6**

From unsustainable to sustainable development - urban problems related to energy - water conservation, rain water harvesting, water shed management - resettlement and rehabilitation of people; its problems and concerns - role of non - governmental organization - environmental ethics: Issues and possible solutions. Environment protection act - Air act - Water act - Wildlife protection act - Forest conservation act - The Biomedical Waste (Management and Handling) Rules; 1998 and amendments - scheme of labeling of environmentally friendly products (Eco mark). Disaster management: floods, earthquake, cyclone and landslides.

Unit V ENVIRONMENT IMPACT ASSESSMENT**5**

Environmental impact analysis (EIA) - Environmental Impact Statement (EIS) - Legal and Regulatory aspects in India – Types and limitations of EIA - Terms of Reference in EIA - Issues in EIA - national – cross sectoral - social and cultural - Case studies of EIA of developmental projects.

Total Periods 30**Text Books:**

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Benny Joseph	Environmental Science and Engineering	Tata McGraw Hill, New Delhi	2006
2.	Gilbert M.Masters	Introduction to Environmental Engineering and Science	2nd edition, Pearson Education	2004

Semester 5

U19MEE05**Dynamics of Machinery**

L	T	P	C
2	1	2	4

Prerequisites : Knowledge of Engineering Mechanics and Kinematics of Machinery

Objectives:

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

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Calculate static and dynamic forces of mechanisms.

CO2 : Calculate the balancing masses and their locations in rotating and reciprocating machines.

CO3 : Compute the frequency of free vibration.

CO4 : Compute the frequency of forced vibration and damping coefficient.

CO5 : Calculate the speed and lift of the governor as well as estimate the gyroscopic effect on automobiles, ships and airplanes.

Unit I FORCE ANALYSIS**9**

Dynamic force analysis – Inertia force and Inertia torque– D Alembert’s principle –Dynamic Analysis in reciprocating engines – Gas forces – Inertia effect of connecting rod– Bearing loads – Crank shaft torque – Turning moment diagrams –Fly Wheels – Flywheels of punching presses- Dynamics of Cam-follower mechanism.

Unit II BALANCING**9**

Static and dynamic balancing – Balancing of rotating masses – Balancing a single cylinder engine – Balancing of Multi-cylinder inline, V-engines – Partial balancing in engines – Balancing of linkages – Balancing machines-Field balancing of discs and rotors.

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– Torsional vibration of shaft – Critical speeds of shafts – Torsional vibration – Two and three rotor torsional systems.

Unit IV FORCED VIBRATION**9**

Response of one degree freedom systems to periodic forcing – Harmonic disturbances – Disturbance caused by unbalance – Support motion –transmissibility – Vibration isolation vibration measurement.

Unit V MECHANISM FOR CONTROL**9**

Governors – Types – Centrifugal governors – Gravity controlled and spring controlled centrifugal governors – Characteristics – Effect of friction – Controlling force curves. Gyroscopes –Gyroscopic forces and torques – Gyroscopic stabilization – Gyroscopic effects in Automobiles, ships and airplanes.

Total Periods 45

LIST OF EXPERIMENTS

1. Determination of Mass moment of inertia of Flywheel.
2. Determination of Mass Moment of Inertia of axisymmetric bodies using Turn Table apparatus.
3. Determination of Mass Moment of Inertia using bifilar suspension and compound pendulum.
4. Study of gyroscopic effect and couple using Motorized gyroscope.
5. Determination of range sensitivity, effort etc., for Watts, Porter, Proell and Hartnell Governors.
6. Determination of natural frequency and damping co-efficient of single degree of freedom spring-mass System.
7. Determination of natural undamped frequency of Equivalent Spring mass system.
8. Determination of torsional undamped natural frequency of single and double rotor systems.
9. Determination of critical speeds of shafts with concentrated loads.
10. Determination of natural undamped frequency of Transverse vibration of Free-Free beam – with and without concentrated masses.
11. Study of Balancing of rotating masses and reciprocating masses.

Total Periods 15

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Rattan. S.S	Theory of Machines, 4 th Edition	Tata McGraw-Hill, New Delhi	2014
2	F. B. Sayyad	Dynamics of Machinery	Tech-Max Educational resources, McMillan Publishers India Ltd	2011

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Uicker, J.J., Pennock G.R and Shigley, J.E.,	Theory of Machines and Mechanisms, 4th Edition,	Oxford University Press	2014
2	Khurmi, R. S	Theory of Machines, 14 th Edition	S Chand Publications,	2005
3	V.Ramamurthi	Mechanics of Machines	Narosa Publishing House	2002
4	Ghosh. A and Mallick, A.K	Theory of Mechanisms and Machines, 3rd Edition	Affiliated East-West Pvt. Ltd., New Delhi	2006
5	Rao.J.S. and Duggipati.R.V	Mechanisms and Machine Theory	Wiley-Eastern Ltd., New Delhi	1992

Web URL(s)

1. <https://nptel.ac.in/courses/112104114/>
2. https://swayam.gov.in/nd1_noc19_ae09/preview

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

U19MEE06	Heat and Mass Transfer	L	T	P	C
	(Use of HMT data book permitted)	2	1	2	4

Prerequisites : Knowledge of Engineering Thermodynamics

Objectives:

- To understand the mechanism of heat transfer under steady and transient condition
- To understand the concepts of heat transfer through the extended surfaces
- To learn the thermal analysis and sizing of heat exchangers
- To expose the mechanism of free and forced convection
- To understand the basic concept of mass transfer.
- To explain diffusion and convective mass transfer

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Apply heat conduction equations to different surface configurations under steady state and transient conditions and solve problems.
- CO2 :** Apply free and forced convective heat transfer correlations to internal and external flows through/over various surface configurations and solve problems.
- CO3 :** Explain the phenomena of boiling and condensation, apply LMTD and NTU methods of thermal analysis to different types of heat exchanger configurations and solve problems
- CO4 :** Explain basic laws for Radiation and apply these principles to radiative heat transfer between different types of surfaces to solve problems.
- CO5 :** Apply diffusive and convective mass transfer equations and correlations to solve problems for different applications.

UNIT I CONDUCTION 9

Basic concepts – mechanisms of heat transfer General Differential equation of Heat Conduction– Cartesian and cylindrical Coordinates – One Dimensional Steady State Heat Conduction — plane and Composite Systems – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis.

UNIT II CONVECTION 9

Free and Forced Convection – Heat transfer coefficients, Boundary Layer concepts. Free and Forced Convection during external flow over vertical and horizontal Plates and Cylinders and Internal flow through tubes.

UNIT III RADIATION 9

Law of radiation – Stefan Boltzmann law, Kirchhoff's law, Black Body Radiation – Grey body radiation - Shape Factor – Electrical Analogy – Radiation Shields.

UNIT IV PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS 9

Boiling – modes - Correlations in boiling Condensation - Nusselt's theory of condensation – Correlations in condensation, Heat Exchanger - Types - Overall Heat Transfer Coefficient – Fouling Factors - Analysis – LMTD method - NTU method.

UNIT V MASS TRANSFER 9

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.

Total Periods 45

LIST OF EXPERIMENTS

1. Thermal conductivity measurement using guarded plate apparatus.
2. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
3. Determination of heat transfer coefficient under natural convection from a vertical cylinder.
4. Determination of heat transfer coefficient under forced convection from a tube.
5. Heat transfer from pin-fin apparatus
6. Determination of Stefan – Boltzmann constant.
7. Determination of emissivity of a grey surface.
8. Effectiveness of Parallel / counter flow heat exchanger

Total Periods 15

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Yunus A. Cengel	Heat Transfer A Practical Approach, 5th Edition	Tata McGraw Hill, New Delhi	2015
2	R.C. Sachdeva	Fundamentals of Engineering Heat & Mass transfer	New Age International Publishers	2009

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Frank P. Incropera and David P. Dewitt	Fundamentals of Heat and Mass Transfer	John Wiley & Sons	1998
2	Nag, P.K	Heat Transfer	Tata McGraw Hill, New Delhi	2002
3	Ozisik, M.N	Heat Transfer	McGraw Hill Book Co	1994
4	Holman, J.P	Heat and Mass Transfer	Tata McGraw Hill	2000
5	R. K. Rajput	Heat and Mass Transfer	S Chand and Company, New Delhi	2007
6	C. P. Kothandaraman and S. Subramanyan	Fundamentals of Heat and Mass Transfer, Rev.3rd edition	New Age International Pvt Ltd, New Delhi,	2006

Web URL(s)

1. <https://nptel.ac.in/courses/112/101/112101097/>
2. <https://nptel.ac.in/courses/112/108/112108149/>
3. <https://nptel.ac.in/courses/112/101/112101002/>
4. <https://nptel.ac.in/courses/112/104/112104159/>
5. <http://www.nptelvideos.in/2012/12/heat-and-mass-transfer.html>

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

U19MET08	Design of Machine Elements	L	T	P	C
		2	1	0	3

Prerequisites : Knowledge of Engineering Mechanics

Objectives:

- To familiarize the various steps involved in the Design Process
- To understand the principle involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.
- To learn to use standard practices and standard data
- To learn to use catalogues and standard machine components

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Explain the influence of steady and variable stresses in machine component design

CO2 : Apply the concepts of design to shafts, keys and couplings

CO3 : Apply the concepts of design to temporary and permanent joints

CO4 : Apply the concepts of design to energy absorbing members, connecting rod and crank shaft.

CO5 : Apply the concepts of design to bearings

Unit I STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS 9

Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading – curved beams – crane hook and ‘C’ frame- Factor of safety - theories of failure – Design based on strength and stiffness – stress concentration – Design for variable loading.

Unit II SHAFTS AND COUPLINGS 9

Design of solid and hollow shafts based on strength, rigidity and critical speed – Keys, keyways and splines - Rigid and flexible couplings.

Unit III TEMPORARY AND PERMANENT JOINTS 9

Threaded fasteners - Bolted joints including eccentric loading, Knuckle joints, Cotter joints – Welded joints, riveted joints for structures - theory of bonded joints.

Unit IV ENERGY STORING ELEMENTS AND ENGINE COMPONENTS 9

Various types of springs, optimization of helical springs - rubber springs - Flywheels considering stresses in rims and arms for engines and punching machines- Connecting Rods and crank shafts.

Unit V BEARINGS 9

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi and Boyd graphs, -- Selection of Rolling Contact bearings

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Bhandari V	Design of Machine Elements, 4 th Edition	Tata McGraw-Hill , New Delhi	2016
2	Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett	Mechanical Engineering Design, 9 th Edition	Tata McGraw-Hill, New Delhi	2011

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Sundararamamoorthy T. V. and Shanmugam .N,	Machine Design	Anuradha Publications, Chennai,	2015
2.	Robert C. Juvinall and Kurt M. Marshek	Fundamentals of Machine Design,4th Edition	John-Wiley	2005
3.	R.B. Patel	Design of Machine Elements	MacMillan Publishers India P Ltd., Tech-Max Educational resources,	2011
4.	P.C. Gope	Machine Design – fundamental and Application	PHI learning private ltd, New Delhi	2012
5.	Ansel Ugural	Mechanical Design – An Integral Approach,1st Edition	Tata McGraw-Hill, New Delhi	2003

Web URL(s)

1. <https://nptel.ac.in/courses/112/105/112105125/>
2. <https://nptel.ac.in/courses/112/105/112105124/>
3. <https://nptel.ac.in/courses/112/106/112106137/>

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

U19MET09

Automobile Engineering

L	T	P	C
3	0	0	3

Objectives:

- To understand the construction and working principle of various parts of an automobile.
- To have the practice for assembling and dismantling of engine parts and transmission system

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Recognize the various parts of the automobile and their functions and materials.
- CO2 :** Discuss the engine auxiliary systems and engine emission control.
- CO3 :** Distinguish the working of different types of transmission systems.
- CO4 :** Explain the Steering, Brakes and Suspension Systems.
- CO5 :** Predict possible alternate sources of energy for IC Engines.

Unit I VEHICLE DESIGN AND ENGINES 9

Types of automobiles vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics, IC engines –components-functions and materials, Variable Valve Timing (VVT).

Unit II FUEL INJECTION SYSTEMS 9

Electronically controlled gasoline injection system for SI engines - EFi, MPFi, GDi , Electronically controlled diesel injection system – CRDI, Unit injector system, Rotary distributor type , Turbo chargers (WGT, VGT), Engine emission control by three way catalytic converter system, Emission norms (Euro and BS).

Unit III POWER TRANSMISSION SYSTEMS 9

Clutch-types and construction, gear boxes- manual and Automatic transmission with intelligent electronic control systems - 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, Bio-diesel, 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

Note: Practical Training in dismantling and assembling of Engine parts and Transmission Systems should be given to the students.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Jain K.K. and Asthana .R.B	Automobile Engineering	Tata McGraw Hill,New Delhi,	2002
2	Kirpal Singh	Automobile Engineering Vol 1&2 , 13 th Edition,	Standard Publishers, New Delhi	2014

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Ganesan V	Internal Combustion engines, 3 rd Edition	Tata McGraw Hill Publishers, New Delhi,	2012
2	Heinz Heisler	Advanced Engine Technology	SAE International Publications, USA	1998
3	Joseph Heitner	Automotive Mechanics, 2 nd Edition,	East-West Press, New Delhi,	1999
4	Martin W, Stockel and Martin T Stockle	Automotive Mechanics Fundamentals	The Good heart - Will Cox Company Inc, USA	1978
5	Newton, Steeds and Garet	Motor Vehicles	Butterworth Publishers	1989

Web URL(s)

1. <https://nptel.ac.in/courses/107/106/107106088/>

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

U19MTT02	Indian Constitution	L	T	P	C
		3	0	0	0

Objectives:

- To impart the knowledge about Indian Constitution and its features..
- To learn about the functions of local administration. .
- To impart the knowledge about functions of State and Union governments/

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Obey the rules and regulations laid down by the state and union governments.

CO2 : Behave as a loyal citizen of the country

CO3 : Become a respectful leader in near future.

CO4 : Understand all the rules and regulations to become a good administrator..

CO5 : Understand the various procedures and processes of election Commission.

Unit I INTRODUCTION 9

Constitution- meaning of the term, Indian Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy

Unit II UNION GOVERNMENT AND ITS ADMINISTRATION 9

Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha

Unit III STATE GOVERNMENT AND ITS ADMINISTRATION 9

Governor: Role and Position, Chief Minister and Council of ministers, State Secretariat: Organization, Structure and Functions

Unit IV LOCAL ADMINISTRATION 9

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati raj: Introduction, PRI: Zila Pachayat, Elected officials and their roles, CEO Zila Pachayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

Unit V ELECTION COMMISSION 9

Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women

Total Periods 45

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	D.D. Basu	Introduction to the Constitution of India, 23 rd Edition	Lexis Nexis, Gudgaon	2015
2.	A. Avasti and A.P. Avasti	Indian Administration	Lakshmi Narain Agarwal Educational Publishers, Agra	2017
3.	S.R. Maheswari	Indian Administration, 6 th Edition	Orient Blackswan, Chennai	2004

Web Url(s)

1. <https://www.iitk.ac.in/wc/data/coi-4March2016.pdf>
2. https://www.india.gov.in/sites/upload_files/npi/files/coi_part_full.pdf

Semester 6

Objectives:

- To provide knowledge on various Metrological equipments available to measure the dimension of the components.
- To provide knowledge on the correct procedure to be adopted to measure the dimension of the components.

Course Outcomes: Upon completing this course, the students

- CO1 :** Understand the objectives of metrology, methods of measurement, standards of measurement & various measurement parameters.
- CO2 :** Explain tolerance, limits of size, fits, geometric and position tolerances, gauges and their design. Understand the working principle of different types of comparators.
- CO3 :** Describe measurement of major & minor diameter, pitch, angle and effective diameter of screw threads.
- CO4 :** Explain measurement systems, transducers, intermediate modifying devices and terminating devices.
- CO5 :** Describe functioning of force, torque, pressure, strain and temperature measuring devices.

Unit I INTRODUCTION TO METROLOGY**9**

Definition, objectives of metrology, Material Standards, Wavelength Standards, Classification of standards, Line and End standards, Calibration of End bars. Numerical examples. Linear measurement and angular measurements: Slip gauges-Indian standards on slip gauges, Adjustable slip gauges, Wringing of slip gauges, Measurement of angle-sine bar, Sine center, Angle gauges, Optical instruments for angular measurements. Autocollimator-Applications for measuring straightness and squareness.

Unit II SYSTEM OF LIMITS, FITS, TOLERANCE AND GAUGING**9**

Definitions- Tolerance analysis-Inter changeability and Selective assembly. Class and grade of tolerance- Fits- Types of fits. Hole base system & shaft base system. Taylor's principle, Types of limit gauges, Numerical on limit gauge design. Comparators: Functional requirements, Classification, Mechanical- Johnson Mikrokator, Sigma comparators, Dial indicator, Electrical comparators, LVDT, Pneumatic comparators- Solex comparators, Optical comparators.

Unit III MEASUREMENT OF SCREW THREAD AND GEAR**9**

Terminology of screw threads, Measurement of major diameter, Minor diameter, Pitch, Angle and Effective diameter of screw threads by 2- wire and 3-wire methods, Best size wire. Screw thread gauges, Toolmaker's microscope. Gear tooth Measurements: Tooth thickness measurement using constant chord method, Addendum, Comparator method and Base tangent method, Measurement of pitch, Concentricity, Run out and In volute profile. Gear roll tester for composite error.

Unit IV BASIC CONCEPTS OF MEASUREMENT SYSTEM AND METHODS**9**

Definition, Significance of measurement, Generalized measurement system, Static characteristics-Accuracy, Precision, Calibration, Threshold, Sensitivity, Hysteresis, Repeatability, Linearity, Loading effect, Dynamic characteristics- System response, Time delay. Errors in measurement, Classification of errors. Transducers: Transfer efficiency, Primary and Secondary transducers, Electrical transducers, Mechanical, Electronic transducers, Relative comparison of each type of transducers. Intermediate Modifying and Terminating Devices: Mechanical systems, Inherent problems, Electrical intermediate modifying devices, Input circuitry, Ballast circuit, Electronic amplifiers. Terminating devices, Cathode ray oscilloscope, Oscillographs.

Unit V APPLIED MECHANICAL MEASUREMENTS**9**

Measurement of force, Torque, Pressure, Types of Dynamometers, Absorption dynamometer, Prony brake and Rope brake dynamometer, and Power Measuring Instruments. Use of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge. Measurement of strain and temperature: Theory of strain gauges, Types, Electrical resistance strain gauge, Preparation and mounting of Strain gauges, Gauge factor, Methods of strain measurement, temperature compensation, Resistance thermometers, Thermocouple, Law of thermocouple, Pyrometer, Optical pyrometer.

Total Periods: 45

List of Experiments

1. Calibration and use of measuring instruments – Vernier caliper, micrometer- Vernier height gauge – using gauge blocks
2. Calibration and use of measuring instruments – depth micrometer, bore gauge, telescopic gauge
3. Measurement of linear dimensions using Comparators
4. Measurement of angles using bevel protractor and sine bar
5. Measurement of screw thread parameters – Screw thread Micrometers and Three wire method (Floating carriage micrometer)
6. Measurement of gear parameters – using gear tooth vernier caliper
7. Non-contact (Optical) measurement using Toolmaker's microscope / Profile projector.
8. Measurement of Surface finish in components manufactured using various processes (turning, milling, grinding, etc.,) using stylus based instruments.
9. Measurement of force
10. Measurement of torque
11. Measurement of temperature

Total Periods: 15

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Gupta. I.C.	Engineering Metrology	Dhanpatrai Publications	2005
2	Jain R.K.	Engineering Metrology	Khanna Publishers	2009

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Beckwith, Marangoni, and Lienhard.	Mechanical Measurements	Pearson Education	2014
2	Donald Peckman	Industrial Instrumentation	Wiley Eastern	2004
3	Alan S. Morris	The essence of Measurement	Prentice Hall of India	1996
4	Charles Reginald Shot bolt	Metrology for Engineers, 5th edition,	Cengage Learning EMEA,	1990

Web URL(s)

1. <https://nptel.ac.in/courses/112/106/112106179/>
2. <https://nptel.ac.in/courses/112/104/112104250/>
3. <https://nptel.ac.in/courses/112/106/112106139/>
4. <https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-me70/>

U19MEE08	Finite Element Analysis	L	T	P	C
		2	1	2	4

Prerequisites : Knowledge of Strength of Materials

Objectives:

- To introduce the concepts of Mathematical Modeling of Engineering Problems.
- To appreciate the use of FEM to a range of Engineering Problems.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Summarize the basics of finite element formulation.
- CO2 :** Apply finite element formulations to solve one dimensional Problems.
- CO3 :** Apply finite element formulations to solve two dimensional scalar Problems.
- CO4 :** Apply finite element method to solve two dimensional Vector problems.
- CO5 :** Apply finite element method to solve problems on iso parametric element and dynamic Problems.

Unit I INTRODUCTION 9

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems–Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

Unit II ONE-DIMENSIONAL PROBLEMS 9

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices - Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation –Transverse deflections and Natural frequencies of beams.

Unit III TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS 9

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non circular shafts –Quadrilateral elements – Higher Order Elements.

Unit IV TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS 9

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations - Plate and shell elements.

Unit V ISOPARAMETRIC FORMULATION 9

Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.

Total Periods 45

LIST OF EXPERIMENTS

1. MATLAB basics, dealing with matrices, Graphing-Functions of one variable and two variables.
2. Use of Mat lab to solve simple problems in vibration.
3. Mechanism Simulation using Multibody Dynamic software.
4. Force and Stress analysis using link elements in Trusses, cables etc.
5. Stress and deflection analysis in beams with different support conditions.
6. Stress analysis of flat plates and simple shells.
7. Stress analysis of axi – symmetric components.
8. Thermal stress and heat transfer analysis of plates.
9. Thermal stress analysis of cylindrical shells.
10. Vibration analysis of spring-mass systems.
11. Model analysis of Beams.
12. Harmonic, transient and spectrum analysis of simple systems.

Total Periods 15

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Reddy. J.N	An Introduction to the Finite Element Method	Tata McGraw-Hill, New Delhi	2005
2	Seshu, P	Text Book of Finite Element Analysis	Prentice-Hall of India Pvt. Ltd., New Delhi	2007

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Bhatti Asghar M	Fundamental Finite Element Analysis and Applications	John Wiley & Sons	2013
2	Chandrupatla & Belagundu	Introduction to Finite Elements in Engineering	Prentice Hall College Div	1990
3	Logan, D.L.	A first course in Finite Element Method	Thomson Asia Pvt. Ltd	2002
4	Rao, S.S.	The Finite Element Method in Engineering	Butterworth Heinemann	2004
5	Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt	Concepts and Applications of Finite Element Analysis	Wiley Student Edition	2002

Web URL(s)

1. <https://nptel.ac.in/courses/112/104/112104115/>

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

U19MET08	Design of Transmission Systems	L	T	P	C
	(Use of PSG Design Data Book permitted)	2	1	0	3

Objectives:

- To gain knowledge on the principles and procedure for the design of Mechanical power Transmission components.
- To understand the standard procedure available for Design of Transmission of Mechanical elements
- To learn to use standard data and catalogues

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Apply the concepts of design to belts, chains and rope drives.

CO2 : Apply the concepts of design to spur, helical gears

CO3 : Apply the concepts of design to worm and bevel gears

CO4 : Apply the concepts of design to gear boxes.

CO5 : Apply the concepts of design to cams, brakes and clutches

Unit I DESIGN OF FLEXIBLE ELEMENTS 9

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

Unit II SPUR GEARS AND PARALLEL AXIS HELICAL GEARS 9

Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects – Fatigue strength - Factor of safety - Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces for helical gears.

Unit III BEVEL, WORM AND CROSS HELICAL GEARS 9

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits-terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

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 - Constant mesh gear box - Speed reducer unit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.

Unit V CAMS, CLUTCHES AND BRAKES 9

Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses. Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches-Electromagnetic clutches. Band and Block brakes - external shoe brakes – Internal expanding shoe brake.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Bhandari V	Design of Machine Elements, 4th Edition	Tata McGraw-Hill Book Co,	2016
2	Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett	Mechanical Engineering Design, 9th Edition,	Tata McGraw-Hill, New Delhi	2011

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Sundararajamoorthy T. V. and Shanmugam .N,	Machine Design	Anuradha Publications, Chennai,	2015
2	Robert C. Juvinall and Kurt M. Marshek	Fundamentals of Machine Design ,4th Edition	John-Wiley	2005
3	Prabhu. T.J.	Design of Transmission Elements	Mani Offset, Chennai	2000
4	Orthwein W	Machine Component Design	Jaico Publishing Co	2003
5	Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger	Design of Machine Elements,8th Edition	Prentice Hall,	2003

Web URL(s)

1. <https://nptel.ac.in/courses/112/106/112106137/>
2. <https://nptel.ac.in/courses/112/105/112105234/>
3. <https://nptel.ac.in/courses/112/105/112105125/>
4. <https://nptel.ac.in/courses/112/105/112105124/>

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

U19MEJ01	Design and Fabrication Project	L	T	P	C
		0	0	6	3

Objectives:

- To develop ability to apply the learned concepts of engineering in designing a working model, to get hands on training in the fabrication of designed models and to teach for the demonstration of their work through presentations

Course Outcome(s):

- Upon completion of the course the student will be able to design, fabricate and demonstrate a working model or real product/process

Guidelines for the conduct of Course

- The students in convenient groups of not more than 4 members have to select a new product/process/process add-on/working model etc. for design and fabrication.
- Every project work shall have a guide who must be the member of the faculty of the department and if essential with an industry guide who may act as co-guide.
- Title of the project must illustrate that something is designed and fabricated
- Three review meetings may be adopted by the head of the department through a project coordinator who is appointed by him for internal assessments
- The students are required to design and fabricate the chosen item in the college and demonstrate its working apart from submitting the project report. The report should contain assembly drawing, parts drawings, process charts relating to fabrication.
- At the end of the semester, the project work shall be evaluated based on oral presentation, the project report and demonstration of working model jointly by external and internal examiners constituted by the Head of the Department.

Total: 60 Periods

Semester 7

Objectives:

- To provide knowledge about Total Quality Management (TQM), TQM tools and Quality systems.

Course Outcomes: Upon completing this course, the students will be able to

- CO1 :** Develop an understanding on quality management philosophies and frameworks
- CO2 :** Adopt TQM methodologies for continuous improvement of quality
- CO3 :** Measure the cost of poor quality, process effectiveness and efficiency to identify areas for improvement.
- CO4 :** Apply benchmarking and business process reengineering to improve management processes.
- CO5 :** Determine the set of indicators to evaluate performance excellence of an organization

Unit I BASIC CONCEPTS 9

Definition of Quality, Dimensions of Quality, Definition of Total quality management, Quality Planning, Quality costs – Analysis, Techniques for Quality Costs, Basic concepts of Total Quality Management.

Unit II HISTORICAL REVIEW OF TQM 9

Quality Council. Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation, Benefits of TQM, Characteristics of successful quality leader, Contributions of Gurus of TQM,

Unit III TQM PRINCIPLES 9

Customer satisfaction - Customer Perception of Quality, Customer Complaints, Service Quality. Customer Retention, Employee Involvement - Motivation, Empowerment teams, Continuous Process Improvement - Juran Trilogy, PDCA Cycle, Kaizen, Supplier Partnership - Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures.

Unit IV TQM TOOLS 9

Benchmarking - Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) - House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) - Concept, Improvement Needs, FMEA - Stages of FMEA The seven tools of quality, Process capability, Concept of six sigma, New seven management tools,

Unit V QUALITY SYSTEMS 9

Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System - Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 - Concept, Requirements and Benefits - Case Studies

Total Periods: 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Subburaj Ramasamy	Total Quality Management	Tata McGraw Hill Publishing Company Ltd., New Delhi,	2005
2	Narayana V and Sreenivasan N.S.,	Quality Management - Concepts and Tasks	<i>New Age International</i> , Delhi,	2009

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Suganthi.L and Anand Samuel	Total Quality Management	Prentice Hall (India) Pvt. Ltd.,	2006
2	Janakiraman. B and Gopal .R.K	Total Quality Management	Prentice Hall (India) Pvt. Ltd.,	2006
3	Dale H.Besterfiled	Total Quality Management	<i>Pearson Education</i> , Delhi	2006
4	James R. Evans and William M. Lindsay	The Management and Control of Quality First Indian Edition	Cengage Learning New Delhi	2012

Web URL(s)

1. <https://nptel.ac.in/courses/110/104/110104080/>
2. <https://nptel.ac.in/courses/110/104/110104085/>
3. <https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-mg39/>

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

Objectives:

- To impart knowledge about the elements and techniques involved in Mechatronics systems which are very much essential to understand the emerging field of automation.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Explain the functioning of mechatronics system with various pneumatic, hydraulic and electrical systems.
- CO2 :** Discuss the functioning of control systems with the help of PLC and microcontrollers
- CO3 :** Classify the various types of actuators and sensor systems based on the principle of operation and application
- CO4 :** Explain the working principles of stepper and DC motors
- CO5 :** Analyze the mechatronics circuits using software.

LIST OF EXPERIMENTS:

1. Study of various types of actuators and transducers
2. Study of various types of sensors
3. Study of hydraulic, pneumatic and electro-pneumatic circuits
4. Study of PLC and its applications
5. Assembly language programming of 8085 – Addition – Subtraction – Multiplication- Division – Sorting – Code Conversion.
6. Stepper motor interface
7. Traffic light interface.
8. Speed control of DC motor
9. Modelling and analysis of basic hydraulic, pneumatic and electrical circuits using Software
10. Study of image processing technique

Total Periods: 30

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

Objectives:

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature
- To develop the methodology to solve the identified problem right from its identification and literature review till the successful solution of the same.
- To enable the students on a project involving theoretical and experimental studies.
- To train the students in preparing project reports and to face reviews as well as viva-voce examination

Course Outcomes:

Upon completion of the course, the student will be able to

- CO1 :** Identify a problem in mechanical engineering field through survey.
- CO2 :** Develop methodology to find the optimal solution for the problem.
- CO3 :** Learn and perform methodology using appropriate modern tools for the problem
- CO4 :** Prepare a report containing the details of the various stages of the project

Guidelines for Review and Evaluation:

- The project work can be an innovative improvement of existing system in the mechanical engineering or inter disciplinary areas and shall include modeling, design, experimentation, evaluation, fabrication or analysis.
- For industrial projects, supervisor from the organization will be a co-guide
- Each project work will be carried out by a team of maximum four students
- The topic of the project will be approved by the Head of the Department under the guidance of a faculty member who is familiar in this area of interest.
- The aim of the project work is to deepen comprehension of principles by applying them to a new problem which may be the design, manufacture of a device, experimentation, simulation of mechanical systems.
- The project period allotted shall be utilized by the students to receive directions from the guide, library reading, laboratory work, computer analysis or field work as assigned by the guide.
- The progress of the project is evaluated based on a minimum of three reviews.
- The review committee may be constituted by the Head of the Department.
- Each team of students shall finally produce a comprehensive report in the prescribed format covering background information, literature survey, problem statement, project work details and conclusion.
- The students will be evaluated through a viva-voce examination by a panel of external and internal examiners constituted by the Head of the Department.

Semester 8

Objectives:

- To enable the students to study the evolution of Management, its functions, principles and to learn the application of the principles of Management in an organization

Course Outcomes: Upon completing this course, the students will be able to

- CO1 :** Understand the managerial functions and types of business organizations
- CO2 :** Apply planning tools and techniques in an organization.
- CO3 :** Organize various activities to be performed in an organization.
- CO4 :** Instruct and direct the employees by motivation in order to achieve the results
- CO5 :** Control all the activities related to an organization and gain the basic knowledge in all aspects of management

Unit I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9

Definition of Management – Science or Art – Manager Vs Entrepreneur - types of managers - managerial roles and skills – Evolution of Management – Scientific, human relations, system and contingency approaches – Types of Business organization - Sole proprietorship, partnership, company-public and private sector enterprises - Organization culture and Environment – Current trends and issues in Management

Unit II PLANNING 9

Nature and purpose of planning – planning process – types of planning – objectives – setting objectives – policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process

Unit III ORGANISING 9

Nature and purpose – Formal and informal organization – organization chart – organization structure – types – Line and staff authority – departmentalization – delegation of authority – centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.

Unit IV DIRECTING 9

Foundations of individual and group behaviour – motivation – motivation theories – motivational techniques – job satisfaction – job enrichment – leadership – types and theories of leadership – communication – process of communication – barrier in communication – effective communication – communication and IT.

Unit V CONTROLLING 9

System and process of controlling – budgetary and non-budgetary control techniques – use of computers and IT in Management control – Productivity problems and management – control and performance – direct and preventive control – reporting

Total Periods: 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Tripathy PC and Reddy PN	Principles of Management	Tata Mcgraw Hill New delhi	2005
2	Harold Koontz and Heinz Weihrich	Essentials of Management	Tata Mcgraw Hill New delhi	2009

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Stephen A. Robbins, David A. Decenzo and Mary Coulter	Fundamentals of Management, 7 th Edition,	Pearson Education	2011
2	Robert Kreitner and Mamata Mohapatra	Management	Biztantra	2008
3	Richard Pettinger	<i>Mastering Organizational Behaviour</i>	Macmillan Press, London,	2009
4	Gail Freeman - Bell and Janes Balkwill	<i>Management in Engineering</i> – Principles and Practice	Prentice Hall of India Pvt.Ltd.,	2008

Web URL(s)

1. <https://nptel.ac.in/courses/110/105/110105146/>
2. https://onlinecourses.nptel.ac.in/noc20_mg58/preview
3. <https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-mg58/>

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

U19MEI01

Industrial Practice / In-plant Training

L	T	P	C
0	0	4	2

Objectives:

- To provide hands-on experience at industry or project site or design office or service sectors where mechanical engineering projects/works are carried out
- To provide industrial exposure in various activities such as production, planning, Quality Assurance, Maintenance, Service, etc

Course Outcomes:

Upon completion of the course, the student will be able to

- CO1 :** Understand the practical applications of theoretical concepts studied in the class rooms.
- CO2 :** Take up any challenging practical problems in industries and find solution by formulating proper methodology
- CO3 :** Demonstrate their practical skills in industries, service centers, project sites and design offices

Guidelines for Review and Evaluation:

- Students have to undergo four-week practical training in Mechanical Engineering related industry / project site/service center/design or planning office of their choice but with the approval of the Head of the Department. At the end of the training, student will submit a report as per the format prescribed by the department.
- This course is mandatory and the student has to pass the course to become eligible for the award of degree. The student shall make a presentation before a committee constituted by the Head of the Department which will assess the student based on the report submitted and the presentation made. Marks and appropriate grades will be assigned as per the regulations.

Objectives:

- To solve the identified problem based on the formulated methodology till to find optimal solution.
- To enable the students on a project involving detailed analytical studies.
- To develop skills in discussing the experimental or test results and make conclusions of the project.

Course Outcomes:

Upon completion of the course, the student will be able to

- CO1 :** Take up any challenging practical problems in industries or research institutions.
- CO2 :** Find optimal solution by formulating proper methodology and manufacturing tools.

Guidelines for the Review and Evaluation:

- The student should continue the phase I work on the selected topic as per the formulated methodology under the same guide/supervisor.
- The progress of the project is evaluated based on a minimum of three reviews.
- The review committee may be constituted by the Head of the Department.
- At the end of the semester, each team of students shall finally produce a comprehensive project report in the prescribed format covering background information, literature survey, problem statement, project work phase-I details and conclusion
- The students will be evaluated through a viva-voce examination by a panel of external and internal examiners constituted by the Head of the Department.

Professional Electives

U19MET50

Design Thinking

L	T	P	C
3	0	0	3

Objectives:

- To enhance innovation activities in students in terms of value creation, speed, and sustainability

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO 1: Appreciate various design process procedure

CO 2: Generate and develop design ideas through different technique.

CO 3: Identify the significance of reverse Engineering to Understand products

CO 4: Understand about Immersion, Analysis and Synthesis.

CO 5: Understand about Ideation and Prototyping

Unit I PROCESS OF DESIGN 9

Introduction – Product Life Cycle - Design Ethics - Design Process - Four Step - Five Step - Twelve Step - creativity and Innovation in Design Process - Design limitation

Unit II GENERATING AND DEVELOPING IDEAS 9

Introduction - Create Thinking - Generating Design Ideas - Lateral Thinking – Analogies – Brainstorming - Mind mapping - National Group Technique – Synthesis - Development of work - Analytical Thinking - Group activities recommended

Unit III REVERSE ENGINEERING 9

Introduction - Reverse Engineering - New Understanding about Products - Reasons for Reverse Engineering - Reverse Engineering Process - Step by Step - Case Studies.

Unit IV STAGES IN DESIGN THINKING-I 9

Immersion: Preliminary immersion, In depth immersion. Analysis and Synthesis: Insight, Affinity diagram, Conceptual Map, Guiding criteria, Empathy map.

Unit V STAGES IN DESIGN THINKING-II 9

Ideation: Brain storming Co-creation workshop - Idea menu- Decision matrix.
Prototyping: Paper prototyping, volumetric model, Staging, Storyboard, Service prototyping- Case studies.

Total Periods 45

S. No	Author (s)	Title of the Book	Publisher	Year of Publications
1	John.R.Karsnitz, Stephen, O'Brien and John P.Hutchinson	Engineering Design, 2nd Edition	Cengage Learning	2013
2	Yousef Haik and Tamer, M .Shahin	Engineering Design Process, 2 nd Edition	Cengage Learning,	2011

1. www.tutor2u.net/business/presentations/.../productlifecycle/default.html
2. https://docs.oracle.com/cd/E11108_02/otn/pdf/.../E11087_01.pdf
3. www.bizfilings.com › Home › Marketing › Product Development
4. <https://www.mindtools.com/brainstm.html>
5. <https://www.quicksprout.com/.../how-to-reverse-engineer-your-competit>
6. www.vertabelo.com/blog/documentation/reverse-engineering

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

U19MET51	Renewable Energy Sources and Systems	L	T	P	C
		3	0	0	3

Objectives:

- To learn about solar radiation and solar thermal system application
- To provide knowledge on fundamentals and sizing of solar photovoltaics.
- To study about the potential and energy conversion process of Wind Energy and Bio Energy.
- To impart fundamental knowledge about Ocean Thermal Energy and Geothermal Energy.
- To provide knowledge about the recent trends in Hydrogen and Fuel Cells.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Understand the solar radiation, and its conversion into heat using solar collectors.
- CO2 :** Explain the working concept of solar photovoltaic system for any isolated applications
- CO3 :** Expose the energy conversion process of wind energy and bio energy.
- CO4 :** Illustrate the fundamentals concepts of ocean thermal energy systems and geothermal thermal energy systems
- CO5 :** Update their knowledge in the field of hydrogen and fuel cells.

Unit I SOLAR THERMAL SYSTEMS 9

Solar radiation spectrum, Radiation measurement, Estimation of average solar radiation, Introduction to solar collectors (liquid flat- Plate collector - Air heater and concentrating collector Solar distillation, Solar drying, Solar thermal system for power generation.

Unit II SOLAR PHOTOVOLTAIC SYSTEMS 9

Operating principle, Photovoltaic cell concepts, Cell, module, array, Voltage current characteristics of a solar cell, Series and parallel connections, Maximum power point tracking, Applications - Battery charging, Pumping, Lighting

Unit III WIND ENERGY AND BIO ENERGY 9

Basic principles of wind energy conversion - classification of wind turbines, Site selection considerations - Merits and demerits of wind energy systems. Biofuels classification, Biomass gasification- Technologies for utilisation of biomass,

Unit IV OCEAN THERMAL ENERGY AND GEOTHERMAL ENERGY 9

Wave energy - Energy from waves, energy potential. Conversion devices. Tidal energy – energy potential, conversion systems. Ocean thermal energy conversion -Methodology, Applications. Geothermal energy - classification of geothermal resources.

Unit V HYDROGEN AND FUEL CELLS 9

Basic properties of hydrogen. Technologies of hydrogen production. Transformation of hydrogen energy - Hydrogen economy. Fuel cells - Operating principle, Specific characteristics, advantages and applications.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Rai. G.D.	Non-Conventional Energy Sources	Khanna Publishers, New Delhi.	2011
2	Twidell, J.W. and Weir, A.,	Renewable Energy Sources	EFN Spon Ltd., UK	2006

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Godfrey Boyle	Renewable Energy: Power for a Sustainable Future, 3 rd Edition	Oxford University Press, UK	2012
2	Chetan Singh Solanki	Solar Photovoltaics, Fundamentals, Technologies and Applications, 3 rd Edition	PHI Learning Private Limited, New Delhi,	2015
3	Sukhatme, Suhas P., and J. K. Nayak.	Solar energy, 4 th Edition	McGraw-Hill Education,	2017
4	Johnson Gary, L	Wind Energy Systems	Prentice Hall, New York,	1985

Web URL(s)

1. https://onlinecourses.nptel.ac.in/noc19_ge11/course
2. <https://nptel.ac.in/courses/103/107/103107157/>
3. <https://nptel.ac.in/courses/121/106/121106014/>
4. <https://nptel.ac.in/courses/108/105/108105058/>

COs	POs												PSOs	
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CO1	3	2	2	1	1	1	3	1	1	1	1	3	2	1
CO2	3	2	2	1	1	1	3	1	1	1	1	3	2	1
CO3	3	2	2	1	1	1	3	1	1	1	1	3	2	1
CO4	3	2	2	1	1	1	3	1	1	1	1	3	2	1
CO5	3	2	2	1	1	1	3	1	1	1	1	3	2	1
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

U19MET52

Power Plant Engineering

L	T	P	C
3	0	0	3

Objectives:

- To impart the knowledge on boilers and steam power plant.
- To learn about the various components associated with steam power plant.
- To study the working of nuclear and hydel power plant.
- To learn about the working of diesel and gas turbine power plant.
- To provide the knowledge on power plants using renewable energy and economics of power plants.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Explain the working principle of steam power plant and boilers.

CO2 : Represent the function of various systems in steam power plant.

CO3 : Indicate the suitable components for nuclear power plants and hydel power plants.

CO4 : Illustrate the working of diesel and gas turbine power plant.

CO5 : Explain the different sources of renewable energy and calculate the economics of power plants

Unit I INTRODUCTION TO POWER PLANTS AND BOILERS 9

Layout of Steam power plant - Components, Selection. Types of Boilers - High pressure and Supercritical boilers - Positive circulation boilers - Fluidized bed boiler - Waste heat recovery boiler- Industrial Standards for boiler. Combined Power Cycles. Comparison and Selection.

Unit II STEAM POWER PLANT 9

Fuel and Ash Handling - Combustion Equipment for burning coal, Mechanical Stokers, Pulveriser, Electrostatic Precipitator, and Mechanical Collectors. Draught -different types. Surface Condenser types. Cooling Towers. Pollution controls.

Unit III NUCLEAR AND HYDEL POWER PLANTS 9

Basics of nuclear fuels - Fission, Fusion Reaction. Layout - Types of Reactors, Pressurized Water Reactor, Boiling Water Reactor, Waste Disposal and safety aspects. Hydro Electric Power Plant – Essential features, classification and operation. Prime mover – types and selection, Draft tubes – types. Selection of Turbines, Governing of Turbines

Unit IV DIESEL AND GAS TURBINE POWER PLANTS 9

Diesel power plants – layout – working, Different systems – Fuel system, lubrication system, Air intake system, Exhaust system, cooling system, Starting system. Gas Turbine Power Plant-Layout, Fuels, Gas Turbine Material, Open and Closed Cycles Reheating, Regeneration and Intercooling.

Unit V OTHER POWER PLANTS AND ECONOMICS OF POWER PLANTS 9

Geo thermal power plant. Ocean thermal energy conversion (OTEC). Tidal power plant. Solar thermal power plant. Wind energy. Fuel Cell power systems. Cost of Electric Energy - Fixed and operating Costs, Economics of load sharing.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	P. K. Nag	Power plant Engineering , 4 th Edition	Tata McGraw Hill, New Delhi	2014
2	R. K. Rajput	Power Plant Engineering, 5 th Edition	Laxmi Publications, Chennai	2016

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	S. C. Arora, S. Domkundwar	A course in Power Plant Engineering	Dhanpatrai & Sons, New Delhi	2016
2	K.K. Ramalingam	Power Plant Engineering	SciTech Publications (India) Private Limited,	2010
3	G. D. Rai	Introduction to Power Plant Technology	Khanna Publishers, New Delhi	2013
4	El Wakil M.M	Power Plant Technology	Tata McGraw Hill, New Delhi	2010
5	Godfrey Boyle	Renewable energy	Open University, Oxford University Press in association with the Open University	2004

Web URL(s)

1. <https://nptel.ac.in/courses/112/107/112107291/>
2. https://swayam.gov.in/nd1_noc19_me63/..
3. <https://nptel.ac.in/courses/112/103/112103277/>

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

U19MET53	Gas Dynamics and Jet Propulsions	L	T	P	C
	(Use of Gas Tables is permitted)	2	1	0	3

Prerequisites : Engineering Thermodynamics

Objectives:

- To understand the basic difference between incompressible and compressible flow.
- To understand the phenomenon of shock waves and its effect on flow. To gain some basic knowledge about jet propulsion and Rocket Propulsion.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Apply the concept of compressible flows in variable area ducts
- CO2 :** Apply the concept of compressible flows in constant area ducts.
- CO3 :** Examine the effect of compression and expansion waves in compressible flow
- CO4 :** Use the concept of gas dynamics in Jet Propulsion
- CO5 :** Apply the concept of gas dynamics in Space 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

UNIT II FLOW THROUGH DUCTS 9

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – 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 – Applications.

UNIT IV JET PROPULSION 9

Theory of jet propulsion – Thrust equation – Thrust power and propulsive efficiency – Operating principle, cycle analysis and use of stagnation state performance of ram jet, turbojet, turbofan and turbo prop engines.

UNIT V SPACE PROPULSION 9

Types of rocket engines – Propellants-feeding systems – Ignition and combustion – Theory of rocket propulsion – Performance study – Staging – Terminal and characteristic velocity – Applications – space flights.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Anderson, J.D	Modern Compressible flow, 3 rd Edition,	McGraw Hill	2012
2	Yahya, S.M.	Fundamentals of Compressible Flow	New Age International (P) Limited, New Delhi	2002

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Cohen. H, GEC Rogers and Saravanamutto	Gas Turbine Theory	Longman Group Ltd	1980
2	Ganesan. V	Gas Turbines	Tata McGraw Hill, New Delhi	2010
3	Shapiro. A.H	Dynamics and Thermodynamics of Compressible fluid Flow	John wiley, New York	1953
4	Sutton. G.P	Rocket Propulsion Elements	John wiley, New York	2010
5	Zucrow. N.J	Principles of Jet Propulsion and Gas Turbines	John Wiley, New York	2010

Web URLs

1. <https://nptel.ac.in/courses/112/106/112106166/>
2. <https://nptel.ac.in/courses/101/106/101106044/>
3. <https://nptel.ac.in/courses/112/103/112103021/>

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

U19MET54	Refrigeration and Air Conditioning	L	T	P	C
		3	0	0	3

Prerequisites : Knowledge of Engineering Thermodynamics

Objectives:

- To understand the underlying principles of operations in different Refrigeration & Air conditioning systems and components.
- To provide knowledge on design aspects of Refrigeration & Air conditioning systems.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Explain the basic concepts of Refrigeration
- CO2 :** Explain the Vapor compression Refrigeration systems and to solve problems.
- CO3 :** Discuss the various types of Refrigeration systems.
- CO4 :** Explain the concepts of Air conditioning
- CO5 :** Calculate load of Air conditioning systems

UNIT I INTRODUCTION 9

Introduction to Refrigeration - Unit of Refrigeration and C.O.P.– Ideal cycles- Refrigerants Desirable properties – Classification - Nomenclature – ODP and GWP.

UNIT II VAPOUR COMPRESSION REFRIGERATION SYSTEM 9

Vapor compression cycle: p-h and T-s diagrams - deviations from theoretical cycle – sub cooling and super heating- effects of condenser and evaporator pressure on COP- multi pressure system - low temperature refrigeration - Cascade systems – problems. Equipments: Type of Compressors, Condensers, Expansion devices, Evaporators.

UNIT III OTHER REFRIGERATION SYSTEMS 9

Working principles of vapour 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 AIR CONDITIONING SYSTEMS 9

Working of summer and winter air conditioning systems, Classifications, Layout of plants, Air distribution system, Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors, Actuators and Safety controls.

UNIT V LOAD ESTIMATION OF AIR CONDITIONG SYSTEM 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 and IAQ principles, effective temperature and chart, calculation of summer and winter air conditioning load

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Arora, C.P	Refrigeration and Air Conditioning, 3rd edition,	McGraw Hill, New Delhi	2010

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Jones W.P	Air conditioning engineering, 5th edition,	Butterworth-Heinemann	2020
2	Roy J. Dossat	Principles of Refrigeration, 4 th edition,	Pearson Education Asia	2009
3	Stoecker, W.F. and Jones J. W	Refrigeration and Air Conditioning, 2 nd Edition	McGraw Hill, New Delhi	1986

Web URL(s)

1. <https://nptel.ac.in/courses/112/105/112105129/>
2. <https://nptel.ac.in/courses/112/107/112107208/>
3. <https://nptel.ac.in/courses/112/105/112105128/>

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

U19MET55	Alternate Fuels for IC Engines	L	T	P	C
		3	0	0	3

Objectives:

- To evaluate the potentials of various alternative fuels for I.C. engines operation
- To develop understanding on production methods of alternative fuels
- To explore further fuel specification and performance requirements for advanced combustion systems.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Introduction to alternative fuels like biofuels – Alcohol , Biodiesel, Biogas
- CO2 :** Compare the properties of various vegetable oil and explain the performance emission and combustion characteristics
- CO3 :** Analyze performance, emission and combustion characteristics of alcohol used in CI and SI engines
- CO4 :** Analyze performance and emission characteristics of hydrogen, biogas and LPG in SI and CI engines
- CO5 :** Analyze environmental effects of combustion of various fuels, suggest modification in their usage.

Unit I **FUELS** **9**

Availability and suitability to piston engines, concept of conventional fuels, potential alternative fuels- ethanol, methanol, hydrogen, LPG, natural gas , producer gas, bio gas and vegetable oils, use in IC engines and merits and demerits of various fuels.

Unit II **VEGETABLE OILS** **9**

Various vegetable oils for engines– structure of vegetable oil– comparison with gasoline and diesel fuel– etherification process– chemical reaction– properties of vegetable oil ester– performance and combustion characteristics of engine using ester as fuel.

Unit III **ALCOHOL FUELS** **9**

Properties as engine fuels- alcohol and gasoline blends- reformed alcohols– use in IC engines– spark assisted diesel engines- surface ignition engines– ignition accelerators– manufacture of alcohol fuels– performance and combustion characteristics in S. I engines

Unit IV **GASEOUS FUELS** **9**

Hydrogen– properties– use in C. I and S.I engines– production methods, producer gas and bio gas– gasification– properties– use in S.I engines, LPG and natural gas– properties– use in S.I and C.I engines. Performance and combustion characteristics S.I and C.I in engine.

Unit V **AVAILABILITY OF FUELS** **9**

Suitability and Future prospects of gaseous fuels in Indian context. Environmental pollution with conventional and alternate fuels, Pollution control methods and packages.

Total Periods 45

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	R.P Sharma & M.L. Mathur,	A Course in Internal Combustion Engines	Danpatrai & Sons	2001
2	Keith Owen and Trevor Eoley	Automotive Fuels Handbook	SAE publications,	1990
3	Richard L.Bechfold	Alternative Fuels Guide Book	SAE International , Warrendale	1997
4	S. Thipse	Alternate Fuels	Jaico Publications	2010
5	V. Ganesan	Internal Combustion Engine	Tata Mc Graw Hill, New Delhi	2012
6	Osamu Hirao and Richard K.Pefley	Present and Future Automotive Fuels	John Wiley and Sons,	1988

Web Url (s)

1. <https://nptel.ac.in/courses/112/103/112103262/>
2. https://nptel.ac.in/content/storage2/courses/112104033/pdf_lecture/lecture39.pdf

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

U19MET56	Hybrid and Electric Vehicles	L	T	P	C
		3	0	0	3

Objectives:

- To illustrate the new generation electric and hybrid vehicles, their operations and controls

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Familiarize the recent development pertaining to energy system
- CO2 :** Understand the recent development in new generation hybrid vehicles.
- CO3 :** Explain hybrid vehicle operation and its control using information technology
- CO4 :** Prepare and maintain proper automated road network.
- CO5 :** Understand the recent technologies in the area of suspension systems, brakes, aerodynamics and safety

Unit I ELECTRIC, HYBRID AND FUEL CELL VEHICLES 9

Layout of Electric vehicle and Hybrid vehicles – Advantages and drawbacks of electric and hybrid vehicles. System components, Electronic control system – Different configurations of Hybrid vehicles. Power split device. High energy and power density batteries – Basics of Fuel cell vehicles.

Unit II NEW GENERATION HYBRID VEHICLES 9

Hybrid Vehicle engines, Stratified charge engines, lean burn engines, low heat rejection engines, hydrogen engines, HCCI engine, VCR engine, surface ignition engines, VVTI engines.

Unit III VEHICLE OPERATION AND CONTROL 9

Computer Control for pollution and noise control and for fuel economy – Transducers and actuators - Information technology for receiving proper information and operation of the vehicle like optimum speed and direction

Unit IV VEHICLE AUTOMATED TRACKS 9

Preparation and maintenance of proper road network - National highway network with automated roads and vehicles - Satellite control of vehicle operation for safe and fast travel, GPS

Unit V SUSPENSION, BRAKES, AERODYNAMICS AND SAFETY 9

Air suspension – Closed loop suspension, compensated suspension, anti-skid braking system, retarders, regenerative braking, safety gauge air bags- crash resistance. Aerodynamics for modern vehicles, safety systems, materials and standards

Total Periods 45

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Iqbal Hussain	Electric & Hybrid Vehicles – Design Fundamentals”, 2 nd Edition,	CRC Press	2011
2	James Larminie	Electric Vehicle Technology Explained	John Wiley & Sons	2003
3	SAE	Advance hybrid vehicle power transmission	SAE Publication	2000
4	SAE	Bosch Hand Book	SAE Publication,	2003
5	Mehrdad Ehsani, Yimin Gao, Ali Emadi	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals	CRC Press	2010
6	Sandeep Dhameja	Electric Vehicle Battery Systems	Newnes	2000

Web URL(s)

1. <https://nptel.ac.in/courses/108/106/108106170/>
2. <https://nptel.ac.in/courses/108/103/108103009/>
3. <https://nptel.ac.in/courses/108/102/108102121/>
4. https://onlinecourses.nptel.ac.in/noc20_ee99/preview

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

U19MET57	Hydrogen and Fuel Cell Technology	L	T	P	C
		3	0	0	3

Objectives:

- To study the basic production techniques of Hydrogen.
- To understand the application and economy of Hydrogen.
- To understand the classifications, construction and working of fuel cells.
- To study the design and performance of fuel cell.
- To provide insights into fuel cell applications and its economics.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Analyze the techniques of Hydrogen gas generation and storage.
- CO2 :** Analyze the application and economics of Hydrogen gas production
- CO3 :** Understand the working principle of operations of different types of fuel cells.
- CO4 :** Analyze the design and performance of full cells.
- CO5 :** Apply the fuel cells for domestic, automotive, space craft power generations and evaluate the techno-economics of fuel cells.

Unit I HYDROGEN- PRODUCTION AND STORAGE 9

Fossil fuels, electrolysis, thermal decomposition, nuclear, photochemical, photo catalytic, hybrid-Hydrogen Storage - Metal hydrides, chemical hydrides, carbon nano-tubes- sea as the source of Deuterium, methane hydrate etc.,

Unit II HYDROGEN APPLICATIONS AND ECONOMY 9

Hydrogen transmission systems. Applications of Hydrogen. Hydrogen as an alternative fuel in IC engines- Suitability of Hydrogen as a fuel, and techno-economic aspects of fuel cell as energy conversion device- Hydrogen fuel for transport

Unit III FUEL CELLS 9

Introduction and overview, operating principle, polarization curves, components, types of fuel cell-AFC, PAFC, DMFC, PEMFC, low and high temperature fuel cells, fuel cell stacks.

Unit IV FUEL CELL DESIGN AND PERFORMANCE 9

Stoichiometric coefficients and utilization percentages of fuels and oxygen, mass flow rate calculation for fuel and oxygen in single cell and fuel cell stack, total voltage and current for fuel cells in parallel and serial connection, over-potential and polarizations, DMFC operation scheme, general issues-water flooding and water management, polarization in PEMFC

Unit V APPLICATION OF FUEL CELL AND ECONOMICS 9

Fuel cell usage for domestic power systems, large scale power generation, Automobile, Space. Economic and environmental analysis on usage of Hydrogen and Fuel cell. Future trends in fuel cells

Total Periods **45**

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Rebecca L. and Busby,	Hydrogen and Fuel Cells: A Comprehensive Guide,	Penn Well Corporation	2005
2	Bent Sorensen	Hydrogen and Fuel Cells: Emerging Technologies and Applications,	Elsevier	2005
3	Kordesch, K and G. Simader	Fuel Cell and Their Applications	Wiley	1996
4	Gupta R. B	Hydrogen Fuel: Production, Transport and Storage	CRC Press	2008
5	Jeremy Rifkin	The Hydrogen Economy	Penguin Group	2002
6	Hart, A.B and G.J.Womack,	Fuel Cells: Theory and Application	Prentice Hall	1989
7	O'Hayre R.,Cha S.W., Colella W., and Prinz F. B	Fuel cell fundamentals, 3 rd Edition	John Wiley	2008

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1. <https://nptel.ac.in/courses/103/102/103102015/>
2. <https://nptel.ac.in/content/storage2/courses/121106014/Week11/lecture34.pdf>
3. <https://nptel.ac.in/content/storage2/courses/121106014/Week11/lecture35.pdf>
4. <https://nptel.ac.in/content/storage2/courses/122101001/downloads/lec-23.pdf>

COs	POs												PSOs	
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CO1	3	2	1	1	1		1					1	1	1
CO2	3	2	1	1	1		1					1	1	1
CO3	3	2	1	1	1		1					1	1	1
CO4	3	2	1	1	1		1					1	1	1
CO5	3	2	1	1	1		1					1	1	1
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

U19MET58

Fuels and Combustion

L	T	P	C
3	0	0	3

Objectives:

- To understand the properties of fuels for the design and operation of the I.C engines.
- To impart the knowledge about combustion in spark ignition and compression ignition engines

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Understand the importance, manufacturing methods, testing methods and combustion methodology of automotive fuels
- CO2 :** Explain the various properties of fuels and their testing
- CO3 :** Understand the relationship between combustion and fuel rating.
- CO4 :** Analyze and impart the fundamentals of combustion processes that occur in automobile vehicles.
- CO5 :** Understand the overall concepts combustion analysis in IC engines.

Unit I MANUFACTURE OF FUELS 9

Structure of petroleum, refining process, fuels, thermal cracking, catalytic cracking, polymerization, alkylation, isomerisation, blending, products of refining process.

Unit II PROPERTIES AND TESTING OF FUELS 9

Thermo-chemistry of fuels, properties and testing of fuels, relative density, calorific value, flash point, fire point, distillation, vapour pressure, spontaneous ignition temperature, viscosity, pour point, flammability, ignitability, diesel index, API gravity, aniline point, carbon residue, copper strip corrosion etc.

Unit III COMBUSTION & FUEL RATING 9

SI Engines – flame propagation and mechanism of combustion, normal combustion, knocking, octane rating, fuel requirements. CI Engine, mechanism of combustion, diesel knock, cetane rating, fuel requirements. Additive - mechanism, requirements of an additive, petrol fuel additives and diesel fuel additives – specifications of fuels.

Unit IV COMBUSTION OF FUELS 9

Chemical composition and molecular structure of hydrocarbon fuels. Combustion Stoichiometry of hydrocarbon fuels – Chemical energy and heat of reaction calculations – Chemical equilibrium and adiabatic flame temperature calculation. Theory of SI and CI engine combustion – Flame velocity and area of flame front. Fuel spray characteristics – droplet size, depth of penetration and atomization

Unit V COMBUSTION ANALYSIS IN IC ENGINES 9

Photographic studies of combustion processes – Analysis of Pressure crank angle diagrams in SI and CI engines. Knock study for Pressure crank angle histories. Apparent heat release rate and Wiebe's law analysis for combustion. Calculation of Ignition delay and combustion duration. – Hot wire and laser Doppler anemometry and velocimetry for flow and combustion analysis in IC engines

Total Periods 45

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Brame, J.S.S. and King, J.G.	Fuels : Solids, Liquids, Gaseous	Edward Arnold	1991
2	Francis, W	Fuels and Fuel Technology Vol. I & II,	Pergamon	1995
3	Mathur. M.L., Sharma. R.P.	A course in internal combustion engines	Dhanpatrai publication	2003
4	B.P. Pundir	Engine Combustion and Emission	Narosa Publishing House	2011
5	Ganesan,V	Internal Combustion Engines	Tata McGraw Hill, New Delhi	1994
6	Willard W. Pulkrabek	Engineering Fundamentals of the Internal Combustion Engines, 2 nd Edition	Pearson Prentice Hall	2007

Web URL(s)

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2. https://nptel.ac.in/content/storage2/courses/105101008/downloads/cete_43.pdf
3. https://nptel.ac.in/content/storage2/courses/112104033/pdf_lecture/lecture39.pdf
4. https://onlinecourses.nptel.ac.in/noc20_de06/preview

COs	POs												PSOs	
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CO1	2	2	1	1	1							1	1	1
CO2	2	2	1	1	1							1	1	1
CO3	2	2	1	1	1							1	1	1
CO4	2	2	1	1	1							1	1	1
CO5	2	2	1	1	1							1	1	1
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

U19MET59

Welding Technology

L	T	P	C
3	0	0	3

Objectives:

- To understand the basics of welding
- To know about the various types of welding processes
- To understand the construction of various welding machines
- To know about the working of various welding machines
- To learn about weld joints, weldability and testing of weldments.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Understand the construction and working principles of gas and arc welding process

CO2 : Understand the construction and working principles of resistance welding process

CO3 : Understand the construction and working principles of various solid state welding process

CO4 : Understand the construction and working principles of various special welding processes

CO5 : Understand the concepts on weld joint design, weldability and testing of weldments

Unit I GAS AND ARC WELDING PROCESSES 9

Fundamental principles – Air Acetylene welding, Oxyacetylene welding, Carbon arc welding, Shielded metal arc welding, Submerged arc welding, TIG & MIG welding, Plasma arc welding and Electroslag welding processes - advantages, limitations and applications

Unit II RESISTANCE WELDING PROCESSES 9

Spot welding, Seam welding, Projection welding, Resistance Butt welding, Flash Butt welding, Percussion welding and High frequency resistance welding processes - advantages, limitations and applications

Unit III SOLID STATE WELDING PROCESSES 9

Cold welding, Diffusion bonding, Explosive welding, Ultrasonic welding, Friction welding, Forge welding, Roll welding and Hot pressure welding processes - advantages, limitations and applications

Unit IV OTHER WELDING PROCESSES 9

Thermit welding, Atomic hydrogen welding, Electron beam welding, Laser Beam welding, Friction stir welding, Under Water welding, Welding automation in aerospace, nuclear and surface transport vehicles.

Unit V DESIGN OF WELD JOINTS, WELDABILITY AND TESTING OF WELDMENTS 9

Various weld joint designs – Welding defects – causes and remedies - Weldability of Aluminium, Copper, and Stainless steels. Destructive and non-destructive testing of weldments

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Parmer R.S	Welding Engineering and Technology	Khanna Publishers, New Delhi	2008
2	Parmer R.S	Welding Processes and Technology	Khanna Publishers, New Delhi	1992

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Nadkarni S.V.	Modern Arc Welding Technology, 1 st Edition	Oxford and IBH, New Delhi,	2005
2	Davis A.C	The Science and Practice of Welding	Cambridge University Press, Cambridge	1993
3	Tylecote R.F.	The Solid Phase Welding of Metals	Edward Arnold Publishers Ltd. London	2000
4	Schwartz M.M.	Metals Joining Manual	McGraw Hill Higher Education	1979

Web URL(s)

1. <https://nptel.ac.in/courses/112/107/112107090/>
2. <https://nptel.ac.in/courses/112/103/112103263/>
3. <https://nptel.ac.in/courses/113/106/113106087/>

COs	POs												PSOs	
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CO1	2	2	2	2					1			1	2	2
CO2	2	2	2	2					1			1	2	2
CO3	2	2	2	2					1			1	2	2
CO4	2	2	2	2					1			1	2	2
CO5	2	2	2	2					1			1	2	2
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

U19MET60	Additive Manufacturing	L	T	P	C
		3	0	0	3

Objectives:

- To educate students with fundamental and advanced knowledge in the field of Additive Manufacturing technology and the associated Aerospace, Architecture, Art, Medical and Industrial applications

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Appreciate the importance of computers and modern tools in manufacturing to reduce cost and matching the societal needs.
- CO2 :** Analyze 2D and 3D models using CAD modeling software and integrating with manufacturing systems.
- CO3 :** Understand the various Additive Manufacturing (AM) techniques and apply them to their potential support in design as well as mass customized manufacturing..
- CO4 :** Apply knowledge on latest techniques of manufacturing in their field of career
- CO5 :** Monitor and control shop floor with the aid of computers

UNIT I INTRODUCTION 9

Need - Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM - Classification of AM processes – Benefits – Applications. Software for AM- Case studies.

UNIT II REVERSE ENGINEERING AND CAD MODELING 9

Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wireframe, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation.

UNIT III LIQUID AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS 9

Stereo lithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and application. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications.

UNIT IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS 9

Selective Laser Sintering (SLS): Principle, process, indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications – case Studies, Selective Laser Melting and Electron Beam Melting

UNIT V OTHER ADDITIVE MANUFACTURING SYSTEMS 9

Three-dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, Demerits, Applications and case studies. Shape Deposition Manufacturing (SDM), Ballistic Particle Manufacturing (BPM), Bio Additive Manufacturing.

Total Periods 45

Text Book

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Chua Chee Kai and Leong Kah Fai	Rapid Prototyping: Principles and Applications in Manufacturing	John Wiley and Sons	1997

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Gibson, I., Rosen, D.W. and Stucker, B	Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing	Springer	2010
2	Gebhardt, A	Rapid prototyping	Hanser Gardener Publications	2003
3	Hilton, P.D. and Jacobs, P.F	Rapid Prototyping and Engineering applications: A tool box for prototype development	CRC press	2005

Web URL(s)

1. <https://nptel.ac.in/courses/112/104/112104265/>
2. <https://nptel.ac.in/courses/110/106/110106146/>

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

U19MET61	Lean Manufacturing	L	T	P	C
		3	0	0	3

Objectives:

- To study the various tools involved in Lean Manufacturing.
- To learn the above tools to implement Lean Manufacturing system in an organization.
- To Understand six sigma techniques
- To study TQM tools and Techniques

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Identify waste in any process, reduce the waste using proper kaizens and other methods
- CO2 :** Improve the productivity of the organization using Lean Manufacturing tools
- CO3 :** Apply TQM tools and techniques for improving productivity of an organization.
- CO4 :** Implement six sigma techniques in efficient way
- CO5 :** Explain the case studies related to Lean Manufacturing for its implementation

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 CELLULAR MANUFACTURING, JIT AND TPM 9

Cellular Manufacturing – Types of Layout, Principles of Cell layout, Implementation. JIT – Principles of JIT and Implementation of Kanban. TPM – Pillars of TPM, Principles and Implementation of TPM.

Unit III SET UP TIME REDUCTION, TQM, 5S AND VSM 9

Set up time reduction – Definition, philosophies and reduction approaches. TQM – Principles and implementation. 5S Principles and implementation - Value stream mapping - Procedure and principles.

Unit IV SIX SIGMA 9

Six Sigma – Definition, statistical considerations, variability reduction, design of experiments – Six Sigma implementation

Unit V CASE STUDIES 9

Various case studies of implementation of lean manufacturing at industries

Total Periods 45

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Ronald G. Askin and Jeffrey B. Goldberg	Design and Analysis of Lean Production Systems	John Wiley & Sons	2003
2	Mikell P. Groover	Automation, Production Systems and CIM	John Wiley & Sons	2000
3	Rother M. and Shook J,	Learning to See: Value Stream Mapping to Add Value and Eliminate Muda	Lean Enterprise Institute, Brookline, MA.	1999

Web URL(s)

1. <https://nptel.ac.in/courses/112/104/112104188/>
2. <https://nptel.ac.in/courses/110/107/110107130/>
3. <https://www.engr.psu.edu/cim/ie450/ie450ho1.pdf>

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	1	2	1	1				1		3	1	2	1
1	1	1	2	1	1				1		3	1	2	1
CO3	1	1	2	1	1				1		3	1	2	1
CO4	1	1	2	1	1				1		3	1	2	1
CO5	1	1	2	1	1				1		3	1	2	1
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

U19MET62	Process Planning and Cost Estimation	L	T	P	C
		3	0	0	3

Objectives:

- To introduce the process planning concepts to make cost estimation for various products after process planning
- To calculate the machining time for various machining operations
- To select the appropriate process, equipment and tools for production of components

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Select the appropriate process, equipment and tools for production of components.

CO2 : Prepare process planning activity chart.

CO3 : Explain the concept of cost estimation and its importance.

CO4 : Compute the job order cost for different type of shop floor.

CO5 : Calculate the machining time for various machining operations.

Unit I INTRODUCTION TO PROCESS PLANNING 9

Introduction- methods of process planning-Drawing interpretation-Material evaluation – steps in process selection-.Production equipment and tooling selection

Unit II PROCESS PLANNING ACTIVITIES 9

Process parameters calculation for various production processes-Selection jigs and fixtures election of quality assurance methods - Set of documents for process planning-Economics of process planning-case studies

Unit III INTRODUCTION TO COST ESTIMATION 9

Importance of costing and estimation –methods of costing-elements of cost estimation –Types of estimates – Estimating procedure- Estimation labor cost, material cost- allocation of over head charges- Calculation of depreciation cost

Unit IV PRODUCTION COST ESTIMATION 9

Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop

Unit V MACHINING TIME CALCULATION 9

Estimation of Machining Time - Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations ,Drilling and Boring - Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	K.C. Jain & L.N. Aggarwal	Production Planning Control and Industrial Management	Khanna Publishers, New Delhi	1990
2	Sinha B.P,	Mechanical Estimating and Costing	Tata-McGraw Hill, New Delhi	1995

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Chitale A.V. and Gupta R.C.,	Product Design and Manufacturing, 2 nd Edition	Prentice Hall India	2002
2	Russell R.S and Tailor B.W,	Operations Management, 4 th Edition	Prentice Hall India	2003
3	Mikell P. Groover	Automation, Production, Systems and Computer Integrated Manufacturing	Pearson Education	2001
4	Ostwalal P.F. and Munez J.,	Manufacturing Processes and systems, 9 th Edition	John Wiley	1998

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2. <https://nptel.ac.in/courses/110/107/110107141/>
3. https://onlinecourses.nptel.ac.in/noc20_me30/preview
4. <https://nptel.ac.in/courses/112/107/112107142/>
5. <https://nptel.ac.in/courses/112/107/112107292/>
6. <https://nptel.ac.in/courses/112/107/112107143/>

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

U19MET63	Automated Manufacturing Systems	L	T	P	C
		3	0	0	3

Objectives:

- To understand the application of computers in various aspects of automated manufacturing viz., design, process planning, manufacturing, cost estimation, layout and material handling systems.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Explain the basic concepts of CAD, CAM and computer integrated manufacturing systems
- CO2 :** Summarize the production planning, computerized process planning and control
- CO3 :** Differentiate the different coding systems used in group technology
- CO4 :** Explain the concepts of flexible manufacturing system (FMS) and automated guided vehicle (AGV) system
- CO5 :** Classify the robots used in industrial applications

Unit I INTRODUCTION 9

Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM – Concurrent Engineering-CIM concepts – Computerised elements of CIM system – Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In-Time Production.

Unit II COMPUTERISED PROCESS PLANNING AND CONTROL 9

Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control-Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) - Simple Problems.

Unit III CELLULAR MANUFACTURING 9

Group Technology(GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Simple Problems

Unit IV FLEXIBLE MANUFACTURING SYSTEM AND AUTOMATED GUIDED VEHICLE SYSTEM 9

Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control – Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety.

Unit V INDUSTRIAL ROBOTICS 9

Robot Anatomy and Related Attributes – Classification of Robots- Robot Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability - Industrial Robot Applications – Robot Part Programming – Robot Accuracy and Repeatability.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Mikell P. Groover	Automation, Production, Systems and Computer Integrated Manufacturing	Prentice Hall India	2008
2	Radhakrishnan P, Subramanyan S. and Raju V	CAD/CAM/CIM, 2 nd Edition	New Age International (P) Ltd, New Delhi	2000

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Kant Vajpayee S,	Principles of Computer Integrated Manufacturing	Prentice Hall India	2002
2	Rao. P, N Tewari and T.K. Kundra	Computer Aided Manufacturing	Tata McGraw Hill	2000
3	Gideon Halevi and Roland Weill	Principles of Process Planning – A Logical Approach	Chapman & Hall, London	1995

Web Url(s)

1. <https://nptel.ac.in/courses/112/104/112104289/>
2. https://onlinecourses.nptel.ac.in/noc21_me65/preview
3. https://onlinecourses.swayam2.ac.in/nou21_me05/preview

COs	POs												PSOs	
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CO1	3	2	2	1	2				1			1	2	1
CO2	3	2	2	1	2				1			1	2	1
CO3	3	2	2	1	2				1			1	2	1
CO4	3	2	2	1	2				1			1	2	1
CO5	3	2	2	1	2				1			1	2	1
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

U19MET64

Plastic Engineering

L	T	P	C
3	0	0	3

Objectives:

- To impart knowledge on the basic concepts of polymers and its mechanisms.
- To understand the mechanical and fracture behavior of plastics. .
- To use the appropriate techniques to design Injection Moulding.
- To select the suitable plastics for various industrial and automobile applications.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Illustrate the types of plastics, its properties and mechanical behavior.
- CO2 :** Identify the suitable plastics for designing plastic components
- CO3 :** Design Injection Moulds with thermal and mechanical features for specific applications
- CO4 :** Apply the suitable plastic processing methods to design plastic products
- CO5 :** Analyze the plastics used in industrial and automobile applications

Unit I SELECTION OF PLASTICS

9

Mechanical Properties- Material Selection for Strength – Degradation - Wear Resistance and Frictional Properties- Special Properties - Mechanical Behavior of Plastics- Short term testing -Long term testing - Design Methods for Plastics using deformation data -Thermal stresses and Strains- - Time Temperature Superposition - Fracture behavior - Creep behavior - Impact behavior

Unit II INTRODUCTION TO MOULD DESIGN

9

Types of moulds and dies for various processing methods - Mould and Die Design Concept and Materials. Injection Mould Design - Basics of mould construction - Methodical Mould Design - Design of Feed System, Ejection System - Venting - Design of Cooling system - Mould alignment concepts and De-moulding Techniques.

Unit III INJECTION MOULD DESIGN

9

Manufacturing Considerations - Mould Filling Considerations - Weld line-Shrinkage and Warpage - Cooling and Solidification - Structural design Considerations - Structural Members-Design for Stiffness - Processing Limitations in Product Design

Unit IV COMPRESSION AND TRANSFER MOULD DESIGN

9

Basics of mould construction - Mould design -Positive moulds- Positive moulds with Lands- Multicavity moulds with individual, common Loading Chamber - Moulds with a slide core - Split cavity moulds

Unit V BLOW MOULD DESIGN

9

Materials Selection, Mould Cooling, Clamping Force, Venting, Pinch-off, Head die design, Parison Diameter Calculation, Wall Thickness, Vertical-load strength, Blow ratio, Base pushup, Neck and Shoulder Design, Thread and beads, Bottom Design. Extrusion Die Design - Die geometry, Die Design, Materials and Classification

Total Periods 45

Text / Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	R J Crawford	Plastics Engineering	Butterworth-Heinemann, Oxford	1999
2	R.G.W.Pye	Injection Mould Design	SPE Publication	2000
3	P.S.Cracknell and R.W Dyson	Handbook of Thermoplastics - Injection Mould Design	Chapman & Hall	1993
4	Laszlo Sors and Imre Balazs	Design of Plastics Moulds and Dies	Elsevier, Amsterdam	1989

Web Url(s)

1. <https://nptel.ac.in/courses/112107086/>
2. https://swayam.gov.in/nd1_noc19_me66/preview

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

U19MET65	Maintenance Engineering	L	T	P	C
		3	0	0	3

Objectives:

- To understand the principles, objectives and importance of maintenance adopted in industry for successful progress.
- To introduce different maintenance categories, its merits and types of lubrication.
- To expose the idea of condition monitoring, methods and instruments used for allied measurements.
- To learn about failure analysis and repair methods for few mechanical elements.
- To promote computerization in maintenance and inventory management.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Explain the principles, objectives and importance of maintenance adopted in industry

CO2 : Select the suitable maintenance category and lubrication type.

CO3 : Apply the appropriate methods and instruments for condition monitoring.

CO4 : Analyze the failures of mechanical systems and select suitable repair methods.

CO5 : Utilize computers in maintenance and inventory management.

Unit I PRINCIPLES OF MAINTENANCE PLANNING 9

Basic principles of maintenance planning - Objectives and principles of planned maintenance activity - Importance and benefits of sound maintenance systems - Maintenance organization - Maintenance economics.

Unit II MAINTENANCE CATEGORIES AND LUBRICATION 9

Maintenance categories - Comparative merits of each category - Preventive maintenance, Maintenance schedules, Repair cycle - Total Productive Maintenance - Principles and methods of lubrication.

Unit III CONDITION MONITORING 9

Condition based maintenance - Cost comparison with and without Condition Monitoring - Methods and instruments for condition monitoring - Noise, vibration, wear and temperature measurement.

Unit IV FAILURE ANALYSIS AND REPAIR METHODS 9

Failure analysis - Failures and their development - Role of Non Destructive Testing in failure analysis - Repair methods for bearings, cylinder block, fuel pump, shaft.

Unit V COMPUTER AIDED MAINTENANCE MANAGEMENT 9

Approach towards Computerization in maintenance - computer-aided maintenance management system (CAMMS) - Advantages of CAMMS - spare parts and inventory centre performance reporting.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Srivastava S.K,	Maintenance Engineering	S Chand and Company	2010
2	Mishra R.C, and Pathak K	Maintenance Engineering and Management, 2 nd Edition	Prentice Hall India Learning Pvt. Ltd.	2013

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Keith Mobley R, Lindley R. Higgins and Darrin J. Wikoff	Maintenance Engineering Handbook, 7 th Edition	McGraw-Hill Professional	2008
2	Davies A,	Handbook of Condition Monitoring: Techniques and Methodology	Springer	2012
3	Otegui Jose Luis	Failure Analysis, Fundamentals and Applications in Mechanical Components, 19 th Edition	Springer	2014

Web URL(s)

1. <https://nptel.ac.in/courses/112/105/112105232/>
2. <https://nptel.ac.in/courses/112/105/112105048/>
3. <https://www.digimat.in/nptel/courses/video/112107241/L11.html>

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

U19MET66	Non-Traditional Machining Processes	L	T	P	C
		3	0	0	3

Objectives:

- To acquire a functional understanding of non-traditional manufacturing equipment.
- To Understand the terminology used in non-traditional manufacturing industries.
- To provide knowledge on the classification of non-traditional machining process.
- To know about various process parameters and their influence on performance and their applications.
- To impart knowledge on various energy involved in non-traditional machining process.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Understand the need of Non Traditional Machining Processes and able to classify various processes.
- CO2 :** Recognize the role of mechanical energy in non-traditional machining processes.
- CO3 :** Apply the knowledge on machining electrically conductive material through electrical energy in non-traditional machining processes.
- CO4 :** Understand the concept of machining the hard material using chemical energy and electrochemical energy.
- CO5 :** Familiarity with various thermal energy based nontraditional machining processes.

Unit I UNCONVENTIONAL MACHINING PROCESS 9

Introduction - Need - Classification - Energies employed in the processes - Brief overview of Abrasive jet Machining (AJM), Water jet machining (WJM), Ultrasonic machining (USM), Electric discharge machining (EDM), Electro-chemical machining (ECM), Electron beam machining (EBM), Laser beam machining (LBM), Plasma arc machining (PAM).

Unit II MECHANICAL ENERGY BASED PROCESSES 9

Abrasive Jet Machining, Water Jet Machining, Abrasive water jet machining and Ultrasonic Machining - Working Principles, Equipment, Process parameters, Material removal rate, Applications.

Unit III ELECTRICAL ENERGY BASED PROCESSES 9

Electric Discharge Machining - Working Principles, Equipment, Process Parameters, Material removal rate, Electrode / Tool, Power Circuits, Tool Wear, Dielectric, Flushing, Wire cut EDM - Applications. Micro EDM- Electric discharge grinding and drilling- Electro-stream drilling.

Unit IV CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES 9

Chemical machining - Etchants, Maskants - techniques. Electro-chemical machining – Working principle, Equipment, Process Parameters, Material removal rate, Electrical circuit. Electro-chemical grinding - Electro-chemical deburring - Electro-chemical honing - Applications.

Unit V THERMAL ENERGY BASED PROCESSES 9

Laser Beam machining, Plasma Arc Machining - Principles, Equipment. Electron Beam Machining - Principles, Equipment, Types, Beam control techniques, Material removal rate - Applications.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	P. K. Mishra	Non-Conventional Machining	Narosa Publishing House, New Delhi	2007
2	P. C. Pandey and H.S. Shan	Modern Machining Processes	Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi	2008
3	Joao Paulo Davim	Nontraditional Machining Processes: Research Advances	Springer, New York	2013

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Paul De Garmo, J.T. Black, and Ronald.A. Kohser	Material and Processes in Manufacturing	Prentice Hall of India Pvt. Ltd., New Delhi	2011
2	Vijaya Kumar Jain	Advanced Machining Processes	Allied Publishers Pvt. Ltd., New Delhi	2005
3	Hassan El-Hofy	Advanced Machining Processes: Nontraditional and Hybrid Machining Processes	McGraw-Hill Professional, New Delhi	2005

Web Url(s)

1. <https://nptel.ac.in/courses/112105212/>
2. https://www.me.iitb.ac.in/~ramesh/courses/ME338/non_trad.pdf
3. http://www.nitc.ac.in/dept/me/jagadeesha/mev303/OVERVIEW_OF_NTM_PROCESSES.pdf
4. https://swayam.gov.in/nd1_noc20_me41/preview

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

U19MET67

Supply Chain Management

L	T	P	C
3	0	0	3

Objectives:

- To provide an insight on the fundamentals of supply chain networks, tools and techniques
- To understand routing and scheduling in transportation network
- To know the role of information technology in supply chain management
- To Design supply chain network based on various requirement

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Understand the framework and scope of supply chain networks and functions.

CO2 : Design supply chain network based on various requirements

CO3 : Implement routing and scheduling in transportation network.

CO4 : Solve the problems due to lack of coordination in supply chain and obstacles

CO5 : Explain the role of information technology in supply chain management.

Unit I INTRODUCTION

9

Role of Logistics and Supply chain Management: Scope and Importance- Evolution of Supply Chain - Decision Phases in Supply Chain - Competitive and Supply chain Strategies – Drivers of Supply Chain Performance and Obstacles.

Unit II SUPPLY CHAIN NETWORK DESIGN

9

Role of Distribution in Supply Chain – Factors influencing Distribution network design – Design options for Distribution Network- Distribution Network in Practice-Role of network Design in Supply Chain – Framework for network Decisions

Unit III LOGISTICS IN SUPPLY CHAIN

9

Role of transportation in supply chain – factors affecting transportations decision – Design option for transportation network – Tailored transportation – Routing and scheduling in transportation

Unit IV SOURCING AND COORDINATION IN SUPPLY CHAIN

9

Role of sourcing supply chain- supplier selection assessment and contracts- Design collaboration - sourcing planning and analysis - supply chain co-ordination - Bull whip effect – Effect of lack of coordination in supply chain and obstacles – Building strategic partnerships and trust within a supply chain.

Unit V SUPPLY CHAIN AND INFORMATION TECHNOLOGY

9

The role IT in supply chain- The supply chain IT frame work Customer Relationship Management – Internal supply chain management – supplier relationship management – future of IT in supply chain –E-Business in supply chain

Total Periods 45

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Sunil Chopra, Peter Meindl and Kalra	Supply Chain Management, Strategy, Planning, and operation,	Pearson Education	2010
2	Srinivasan G.S,	Quantitative models in Operations and Supply Chain Management	Prentice Hall India	2010
3	David J.Bloomberg, Stephen Lemay and Joe B.Hanna	Logistics	Prentice Hall India	2002
4	Jeremy F.Shapiro	Modeling the supply chain	Thomson Duxbury	2002
5	James B.Ayers	Handbook of Supply chain management	St. Lucie press	2000

Web Url(s)

1. <https://nptel.ac.in/courses/110/106/110106045/>
2. <https://nptel.ac.in/courses/110/107/110107074/>
3. <https://nptel.ac.in/courses/110/105/110105141/>
4. <https://nptel.ac.in/courses/110/108/110108056/>
5. https://onlinecourses.nptel.ac.in/noc21_mg45/preview

COs	POs												PSOs	
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CO1	1	1	2				2		1		3	1	2	1
CO2	1	1	2				2		1		3	1	2	1
CO3	1	1	2				2		1		3	1	2	1
CO4	1	1	2				2		1		3	1	2	1
CO5	1	1	2				2		1		3	1	2	1
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

U19MET68	Marketing Management	L	T	P	C
		3	0	0	3

Objectives:

- To enable students to deal with newer concepts of marketing concepts like strategic marketing segmentation, pricing, advertisement and strategic formulation.
- To enable a student to take up marketing as a professional career.
- To explore the launch of new product in the market

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Explain the steps involved in marketing process.

CO2 : Enhance the knowledge about Marketer's Practices regarding buying behavior and market segmentation.

CO3 : Understand insights on Advertising, Branding and Retailing.

CO4 : Formulate strategy and marketing planning in an Organization for exhibiting skills required to achieve higher goals.

CO5 : Conduct Marketing Research to explore the launch of new product in the market.

Unit I MARKETING PROCESS 9

Definition, Marketing process, dynamics, needs, wants and demands, marketing concepts, environment, mix, types. Philosophies, selling versus marketing, organizations, industrial versus consumer marketing, consumer goods, industrial goods, product hierarchy

Unit II BUYING BEHAVIOUR AND MARKET SEGMENTATION 9

Cultural, demographic factors, motives, types, buying decisions, segmentation factors - demographic - Psycho graphic and geographic segmentation, process, patterns

Unit III PRODUCT PRICING AND MARKETING RESEARCH 9

Objectives, pricing, decisions and pricing methods, pricing management. Introduction, uses, process of marketing research

Unit IV MARKETING PLANNING AND STRATEGY FORMULATION 9

Components of marketing plan-strategy formulations and the marketing process, implementations, portfolio analysis, BCG, GEC grids

Unit V ADVERTISING, SALES PROMOTION AND DISTRIBUTION 9

Characteristics, impact, goals, types, and sales promotions - point of purchase - unique selling proposition. Characteristics, wholesaling, retailing, channel design, logistics, and modern trends in retailing, Modern Trends, e-Marketing.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Philip Kotler and Keller	Marketing Management, 14 th Edition	Prentice Hall of India,	2012
2	Chandrasekar, K.S.,	Marketing Management Text and Cases, 1 st Edition	Tata McGraw Hill,	2010

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Donald S. Tull and Hawkins	Marketing Research	Prentice Hall of India	1997
2	Philip Kotler and Gary Armstrong	Principles of Marketing	Prentice Hall of India	2000
3	Czinkota and Kotabe	Marketing Management	Thomson learning, Indian Edition	2007

Web URL(s)

1. <https://nptel.ac.in/courses/110/104/110104068/>
2. <https://nptel.ac.in/courses/110/104/110104070/>
3. <https://nptel.ac.in/courses/110/108/110108141/>
4. <https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-mg28/>

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

Objectives:

- To introduce the concepts of work study and ergonomics in industrial operations.
- To give an overview of decision making in manufacturing and service operations

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Implement principles of management in an organization.
- CO2 :** Introduce tools and techniques of motion and time study.
- CO3 :** Analyze various aspects of job evaluation and ergonomics
- CO4 :** Apply appropriate basic analytical techniques related to production planning and control.
- CO5 :** Recognize and apply appropriate basic analytical techniques related to wages and incentives.

Unit I WORK MEASUREMENT AND WORK STUDY 9

Work measurement, Techniques- Production study, Time study, Standard time-Rating factors- Work sampling, Work study, Techniques- Human factors- Work study and productivity-method study, Techniques and procedures- charging Techniques- Motion economy principles- SIMO chart- Ergonomics' and Industrial design.

Unit II PLANT LAYOUT AND MATERIAL HANDLING 9

Plant location, site selection- Plant layout types, need, factors influencing the layout - Tools and techniques for developing layout, process chart, flow diagram, string diagram, Template and Scale models- Layout Planning procedure- Assembly line balancing. Material Handling, scope and importance- Types of material handling systems-factors influencing material handling- methods of material handling

Unit III WORK DESIGN ERGONOMICS, PRODUCTION & PRODUCTIVITY 9

Introduction to work design-Work design-for increased productivity, the work system design. Introduction to job design- Effective job design-Environmental factors, organizational factors & behavioral factors. Ergonomics-Objectives' system approach of ergonomic model-Man-machine system Production and productivity-Definition of production, function and type of production- Definition of productivity- Productivity measurement.

Unit IV PRODUCTION PLANNING AND CONTROL 9

Objectives of PPC- Functions of PPC- Aspects of product development and design- Process Planning- Principles of Standardization, specialization, Simplification-Group Technology- Optimum Batch size- ABC analysis-Value Engineering

Unit V WAGES AND INCENTIVES 9

Wages and salary administration- Meaning principles- Techniques of wage fixation- Job evaluation- Merit rating- Methods of wage payment. Incentive scheme, Types, Advantages and disadvantages- Productivity base incentives, Case Example- Evaluation of incentive scheme.

Total Periods 45

Text Books:

S.No	Authir(s)	Title of the Book	Publisher	Year of Publication
1.	Khanna.O.P	Industrial Engineering and Management	Dhanpat Rai Publications Pvt Ltd	2010
2.	Samuel Eilon	Elements of Production Planning and Control	McMillan and Co., Digitized	2007

Reference Books:

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Kumar.B,	Industrial Engineering and Management 9th edition	Khanna Publishers, New Delhi,	2005
2.	Seetharama L. Narasimhan, Dennis W. Mc Leavey and Peter J.Billington	Production Planning and Inventory Control” , 2nd Edition,	Prentice Hall India	2002
3.	Maynard.H	Industrial Engineering Hand Book	McGraw Hill Book Co., New York,,	2010
4.	Chandler Allen Phillips	Human Factors Engineering	John Wiley and Sons, New York	2000

Web Url(s):

1. <https://nptel.ac.in/courses/112/107/112107238/>
2. <https://nptel.ac.in/courses/110/107/110107141/>
3. https://onlinecourses.nptel.ac.in/noc20_me30/preview
4. <https://nptel.ac.in/courses/112/107/112107142/>
5. <https://nptel.ac.in/courses/112/107/112107292/>
6. <https://nptel.ac.in/courses/112/107/112107143/>

COs	POs												PSOs	
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CO1	2	3	2	3					1			1	2	1
CO2	2	3	2	3					1			1	2	1
CO3	2	3	2	3					1			1	2	1
CO4	2	3	2	3					1			1	2	1
CO5	2	3	2	3					1			1	2	1
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

U19MET70 Internet of Things for Mechanical Applications	L	T	P	C
	3	0	0	3

Objectives:

- To impart knowledge on state of art IoT architecture and data management
- To learn the applications of Devices and Gateways in IoT technology

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Understand the vision of IoT from a global context
- CO2 :** Determine the Market perspective of IoT.
- CO3 :** Build state of the art architecture in IoT
- CO4 :** Understand the design constraints in the real world
- CO5 :** Apply of IoT in Industrial Automation and Real World Design Constraints

Unit I INTRODUCTION 9

Machine to Machine (M2M) to IoT-The Vision-Introduction, From M2M to IoT, M2M towards IoT-the global context, A use case example, Differing Characteristics.

Unit II IoT STRUCTURE 9

M2M to IoT – A Market Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. **M2M to IoT-An Architectural Overview**– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

Unit III IoT NETWORKING 9

M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management

Unit IV IoT ARCHITECTURE 9

IoT Architecture-State of the Art – Introduction, State of the art, **Architecture Reference Model**- Introduction, Reference Model and architecture, IoT reference Model

Unit V ARCHITECTURE MODELING 9

IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. **Real-World Design Constraints**- Introduction, Technical Design constraints-hardware is popular again, Data representation and visualization, Interaction and remote control. **Industrial Automation**- Service-oriented architecture-based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things, **Commercial Building Automation**- Introduction, Case study: phase one-commercial building automation today, Case study: phase two-commercial building automation in the future

Total Periods 45

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Francis, daCosta Henderson, Byron	Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, 1 st Edition	A press Publications,	2013
2	Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos and David Boyle,	From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, 1 st Edition	Academic Press ,USA	2014
3	Vijay Madiseti and Arshdeep Bahga	Internet of Things : A Hands-on-Approach , 1 st Edition	VPT	2014

Web URL(s)

1. https://onlinecourses.nptel.ac.in/noc20_cs24/preview
2. https://onlinecourses.nptel.ac.in/noc21_cs17/preview
3. <https://nptel.ac.in/courses/106/105/106105166/>
4. <https://nptel.ac.in/courses/108/108/108108098/>
5. <https://books.google.co.in/books?id=JPKGBAAQBAJ&lpg=PA1&pg=PA1#v=onepage&q&f=false>

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

U19MET71	Failure Analysis in Design	L	T	P	C
		3	0	0	3

Objectives:

- To understand the various modes of failure for safe design of mechanical components
- To learn about various types of fracture mechanisms associated with failure of a component.
- To provide basic knowledge about the effects of corrosion in failure.
- To learn about the role of environmental effects in failure of a component.
- To impart the knowledge about various failure analysis tools.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Analyze different modes of failure while designing a mechanical component.
- CO2 :** Explain the material behavior while fracture loading
- CO3 :** Explore the various fracture mechanisms affecting safe design.
- CO4 :** Predict the failure of a component due to corrosion and fatigue.
- CO5 :** Use various failure analysis tools for a safe design of mechanical components.

Unit I MATERIALS AND DESIGN PROCESS 9

Factors affecting the behavior of materials in components – effect of component geometry and shape factors- design for high static strength, stiffness and low toughness materials – material selection process – introduction to two and three dimensional state of stresses - Mohr's circle – hydrostatic stress – Von-Mises shear stress.

Unit II FRACTURE MECHANICS 9

Ductile and brittle fractures – cleavage fractography – factors affecting ductile to brittle fracture transition – fracture mechanics approach to design – energy criterion – stress intensity approach – time dependent crack growth and damage – stress analysis of cracks – stress intensity factors – crack growth instability analysis.

Unit III FATIGUE 9

Statistical nature of fatigue – signal to noise curve – structural feature of fatigue – effect of stress concentration – fracture crack propagation – metallurgical variables on fatigue – designing against fatigue – fatigue of bolted, welded and adhesive joints – fatigue tests – purpose, specimen, procedures and evaluation of test results – crack growth measurement – creep – elevated temperature fatigue – super plasticity.

Unit IV CORROSION AND WEAR FAILURES 9

Types of corrosion – factors influencing corrosion failures – sources, characteristics and analysis of stress corrosion cracking - various types of hydrogen damage failures – corrective and preventive actions – types of wear – lubricated and non lubricated wear – wear on different materials – different methods of wear measurement – role of friction on wear – analysis of wear failures – wear tests – ferrography

Unit V FAILURE ANALYSIS TOOLS 9

Reliability concept and hazard function – application of poisson, exponential and Weibull distribution for reliability – bathtub curve – parallel and series system – failure mode effect analysis – design , types, process and industrial case studies.

Total Periods 45

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	T.L. Anderson	Fracture Mechanics : Fundamentals and applications	CRC Press	2007
2	William T. Becker and Roch J. Shipley	Failure Analysis and Prevention ASM Handbook Vol. II	ASM Metals Park, Ohio, USA	2002
3	Prashant Kumar	Elements of Fracture Mechanics	Wheeler Publishing	1999
4	J.E. Shigley	Mechanical Engineering Design	McGraw Hill	2000
5	F Michael and Ashby	Material Selection in Mechanical Design	Butterworth Heinemann	2004

Web URL(s)

1. <https://nptel.ac.in/courses/112107241/>
2. <https://www.coursera.org/learn/machine-design> 1/

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	1	2	2				1			1	2	1
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CO4	2	2	1	2	2				1			1	2	1
CO5	2	2	1	2	2				1			1	2	1
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

U19MET72	Concepts of Engineering Design	L	T	P	C
		3	0	0	3

Objectives:

- To impart knowledge on the concepts of Engineering Design process.
- To learn the different types of tools and techniques involved in creative design process.
- To study environmental, ethical and social issues during innovative design process

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Understand the conceptual development techniques to find solution for a critical design issue.
- CO2 :** Apply embodiment principles to translate the conceptual ideas to engineering design
- CO3 :** Apply environmental, ethical and social issues during innovative design process
- CO4 :** Develop the concepts for product architecture.
- CO5 :** Design and develop innovative engineering products for industrial needs using robust design philosophy.

Unit I INTRODUCTION 9

Innovations in Design, Engineering Design Process, Prescriptive and integrative models of design, Design Review and societal considerations- Need for creativity, Generating creative ideas – the seven Da-Vincian principles, Typology of idea generation activities, Principles of creativity, Creativity and serentipity

Unit II IDENTIFICATION OF CUSTOMER NEEDS 9

Evaluating Customer requirements and survey on customer needs, Conversion of customer needs into technical Specifications, Information sources

Unit III CONCEPT GENERATION AND EVALUATION 9

Creativity and Problem solving, Brainstorming, Theory of Inventive Problem solving (TRIZ), Functional Decomposition of the problem for innovative concept development, Morphological design, Introduction to Axiomatic Design, Concept evaluation and decision making.

Unit IV EMBODIMENT DESIGN 9

Introduction, Product Architecture, Configuration and Parametric design Concepts, Industrial Design.

Unit V DESIGN FOR X 9

Design for Manufacturing, Design for Assembly, Design for Environment, Design for Reliability and Robustness, Introduction to FMEA.

Total Periods 45

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Nigel Cross	Engineering Design Methods	John Wiley	2009
2	George E. Dieter,	Engineering Design	McGraw-Hill	2009
3	Genrich Altshuller	The Innovation Algorithm	Technical Innovation Centre	2011
4	Myer Kurtz	Environmentally Conscious Mechanical Design	John Wiley & Sons Ltd	2007
5	Gopalakrishnan.P.S	Ideas, Creativity and Innovation: Keys to Survival	ICFAI university press	2008
6	Srikant Surya Pala A,	TRIZ: A New Framework for Innovation Concepts and Cases	ICFAI university press	2008

Web URL(s)

1. <https://nptel.ac.in/courses/107/101/107101087/>
2. <https://nptel.ac.in/courses/107/103/107103002/>
3. <https://nptel.ac.in/courses/107/103/107103002/>
4. <https://nptel.ac.in/courses/107/104/107104078/>
5. <https://nptel.ac.in/courses/107/101/107101086/>

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

U19MET73	Computational Fluid Dynamics	L	T	P	C
		3	0	0	3

Prerequisites : Knowledge of Finite Element Analysis

Objectives:

- To introduce Governing Equations of viscous fluid flows.
- To introduce numerical modeling and its role in the field of fluid flow and heat transfer.
- To enable the students to understand the various discretization methods, solution procedures and turbulence modeling.
- To create confidence to solve complex problems in the field of fluid flow and heat transfer by using high speed computers.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Derive the governing equations and boundary conditions for fluid dynamics.

CO2 : Analyze Finite difference and Finite volume methods for Diffusion.

CO3 : Analyze Finite volume method for Convective diffusion.

CO4 : Analyze Flow field problems.

CO5 : Explain and solve the Turbulence models and Mesh generation techniques.

Unit I GOVERNING EQUATIONS AND BOUNDARY CONDITIONS 9

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

Unit II FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION 9

Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – Finite volume formulation for steady state One, Two and Three - dimensional diffusion problems –Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations – Use of Finite Difference and Finite Volume methods.

Unit III FINITE VOLUME METHOD FOR CONVECTION DIFFUSION 9

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law, QUICK Schemes.

Unit IV FLOW FIELD ANALYSIS 9

Finite volume methods -Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms.

Unit V TURBULENCE MODELS AND MESH GENERATION 9

Turbulence models, mixing length model, Two equation (k- ϵ) models – High and low Reynolds number models – Structured Grid generation – Unstructured Grid generation – Mesh refinement – Adaptive mesh – Software tools.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Ghoshdastidar, P.S.	Computer Simulation of flow and heat transfer	Tata McGraw-Hill.	2017
2	Versteeg, H.K., and Malalasekera, W	An Introduction to Computational Fluid Dynamics: The finite volume Method	Pearson Education Ltd	2007

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Anil W. Date	Introduction to Computational Fluid Dynamics	Cambridge University Press	2005
2	Chung, T.J.	Computational Fluid Dynamics	Cambridge University Press	2002
3	Ghoshdastidar P.S.	Heat Transfer	Oxford University Press	2005
4	Muralidhar, K., and Sundararajan, T.,	Computational Fluid Flow and Heat Transfer	Narosa Publishing House, New Delhi	2014
5	Patankar, S.V.	Numerical Heat Transfer and Fluid Flow	Hemisphere Publishing Corporation	2004

Web URL(s)

1. <https://nptel.ac.in/courses/112/105/112105045/>

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

U19MET74	Design of Jigs, Fixture and Press Tool (Use of Approved Design Data Book permitted)	L	T	P	C
		3	0	0	3

Objectives:

- To impart knowledge on location and clamping principles
- To understand the functions and design principles of Jigs and fixtures
- To make known the techniques of press tool technology
- To acquire the knowledge in dies and relevant details
- To develop ability for dealing on site problems associated in shop floor

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Apply the principle of jigs and fixtures in holding work
- CO2 :** Design and develop the work holding process for any operation
- CO3 :** Exhibit the technologies available for ease of pressing operation
- CO4 :** Develop the dies for various bending, forming and drawing operations
- CO5 :** Implement the principles of Jigs and Fixtures in any on field production activities.

Unit I LOCATING AND CLAMPING PRINCIPLES 9

Objectives of tool design- Function and advantages of Jigs and fixtures – Basic elements – principles of location – Locating methods and devices – Redundant Location – Principles of clamping – Mechanical actuation – pneumatic and hydraulic actuation Standard parts – Drill bushes and Jig buttons – Tolerances and materials used

Unit II JIGS AND FIXTURES 9

Design and development of jigs and fixtures for given component- Types of Jigs – Post, Turnover, Channel, latch, box, pot, angular post jigs – Indexing jigs – General principles of milling, Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Modular fixturing systems- Quick change fixtures.

Unit III ELEMENTS OF CUTTING DIES 9

Press Working Terminologies – operations – Types of presses – press accessories – Computation of press capacity – Strip layout – Material Utilization – Shearing action – Clearances – Press Work Materials – Center of pressure- Design of various elements of dies – Die Block – Punch holder, Die set, guide plates – Stops – Strippers – Pilots – Selection of Standard parts – Design and preparation of four standard views of simple blanking, piercing, compound and progressive dies

Unit IV BENDING, FORMING AND DRAWING DIES 9

Difference between bending, forming and drawing – Blank development for above operations – Types of Bending dies – Press capacity – Spring back – knockouts – direct and indirect – pressure pads – Ejectors – Variables affecting Metal flow in drawing operations – draw die inserts – draw beads-ironing – Design and development of bending, forming, drawing reverse re-drawing and combination dies – Blank development for axis- symmetric, rectangular and elliptic parts – Single and double action dies.

Unit V SPECIAL DIES 9

Bulging, Swaging, Embossing, coining, curling, hole flanging, shaving and sizing, assembly, fine Blanking dies – recent trends in tool design- computer Aids for sheet metal forming Analysis – basic introduction - tooling for numerically controlled machines- setup reduction for work holding – Single minute exchange of dies – Poka Yoke - Course should be supplemented with visits to industries.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Joshi, P.H.	Jigs and Fixture	Tata McGraw Hill, New Delhi	2004
2	Joshi, P.H.	Press Tools : Design and Construction	Wheels publishing Co	1996

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Donaldson, Lecain and Goold	Tool Design	Tata McGraw Hill, New Delhi	2000
2	K. Venkataraman,	Design of Jigs Fixtures & Press Tools	Tata McGraw Hill, New Delhi	2000

Web URL(s)

1. <https://nptel.ac.in/content/storage2/courses/112105127/pdf/LM-33.pdf>
2. <https://nptel.ac.in/content/storage2/courses/112105127/pdf/LM-34.pdf>
3. http://www.nitc.ac.in/dept/me/jagadeesha/mev303/CHAPT_INTRODUCTION_TO_JIGS_AND%20FIXTURES.pdf

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

U19MET75	Design for Manufacturing, Assembly and Environment	L	T	P	C
		3	0	0	3

Objectives:

- To create knowledge about the design factors which are influencing the manufacturing process
- To select proper manufacturing process with the environment concerns.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1 : Analyse the design principles for manufacturability

CO2 : Selection of methods for productivity with considerations of factors

CO3 : Analyse the design considerations for machining the components

CO4 : Selection of component design for casting

CO5 : Selection of materials for the design of experiments

UNIT I DESIGN PRINCIPLES FOR MANUFACTURABILITY 9

General design principles for manufacturability – Mechanical properties of material: Tensile properties, Engineering stress-strain, True stress strain, Compression properties, Shear properties, mechanisms selection, evaluation method, process capability – feature tolerances –geometric tolerances – assembly limits –datum features – tolerance stacks.

UNIT II FACTORS INFLUENCING FORM DESIGN 9

Working principle, material, manufacture, design- possible solutions - materials choice - influence of materials on form design - form design of welded members, forgings and castings.

UNIT III MACHINING COMPONENT DESIGN 9

Design features to facilitate machining - drills - milling cutters - keyways - reduction of machined area- simplification by separation - simplification by amalgamation - design for machinability - design for economy - design for clampability - design for accessibility - design for assembly. Recommended materials for machinability, Design recommendations - Design for machining round holes: Introduction, Suitable materials, Design recommendations, Recommended tolerances.

UNIT IV CASTING COMPONENT DESIGN 9

Redesign of castings based on parting line considerations - minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - modifying the design - group technology. Die casting: Introduction to die casting, Applications, Suitable material consideration, General design consideration, Specific design recommendation, Design for powder metal processing: Introduction to powder metal processing, Typical characteristics and applications, Design recommendations.

UNIT V DESIGN FOR ENVIRONMENT 9

Introduction – environmental objectives – global issues – regional and local issues – basic DFE methods – design guidelines – lifecycle assessment method – techniques to reduce environmental impact –design for energy efficiency – design to regulations and standards.

Total Periods 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	G. Boothroyd, P. Dewhurst and W. Knight	Product Design for Manufacture and Assembly	Marcell Dekker	2002
2	Harry Peck	Design for Manufacture	Pitman Publishers	1983

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Boothroyd, G	Design for Assembly Automation and Product Design	Marcel Dekker	1980
2	Hilton, P.D. and Jacobs, P.F	Design for Manufacture Handbook	McGraw hill	1995
3	J. G. Bralla	Hand Book of Product Design for Manufacturing	McGraw Hill	2002

Web URL(s)

1. <https://www.edx.org/course/fundamentals-of-manufacturing-processes-2>
2. <https://nptel.ac.in/courses/107103012/>
3. <https://nptel.ac.in/courses/112/101/112101005/>

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

U19MET76

Product Design

L	T	P	C
3	0	0	3

Objectives:

- To provide the basic concepts of product design, product features and its architecture
- To impart basic knowledge in the common features a product and incorporate them suitably in product.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO1 :** Design and development some products for the given set of applications
- CO2 :** Make a prototype by utilizing the knowledge gained through prototyping technology
- CO3 :** Establish product architecture by creating detailed interface specifications
- CO4 :** Explain the design process by incorporating CAD, CAM and CAE tools
- CO5 :** Execute the product development activities in economical way.

Unit I INTRODUCTION 9

Need for IPPD – Strategic importance of Product development – integration of customer, designer, material supplier and process planner, Competitor and customer – Behaviour analysis. Understanding customer – prompting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specifications.

Unit II CONCEPT GENERATION AND SELECTION 9

Task – Structured approaches – clarification – search – externally and internally – explore systematically – reflect on the solutions and processes – concept selection – methodology – benefits.

Unit III PRODUCT ARCHITECTURE 9

Implications – Product change – variety – component standardization – product performance – manufacturability – product development management – establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailed interface specifications

Unit IV INDUSTRIAL DESIGN 9

Integrate process design – Managing costs – Robust design – Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically – Need for industrial design – impact – design process – investigation of for industrial design – impact – design process – investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.

Unit V DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT 9

Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs – Minimize system complexity – Prototype basics – principles of prototyping – planning for prototypes – Economic Analysis – Understanding and representing tasks – baseline project planning – accelerating the project – project execution

Total Periods 45

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Kari T.Ulrich and Steven D.Eppinger	Product Design and Development	McGraw-Hill International Editions	1999
2	Kemmneth Crow	Concurrent Engineering ./ Integrated Product Development	DRM Associates, 26/3, Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book.	1992
3	Stephen Rosenthal	Effective Product Design and Development	One Orwin, Homewood, , ISBN 1-55623-603-4.	1992
4	Staurt Pugh	Tool Design :Integrated Methods for Successful Product Engineering	Addison Wesley Publishing, New York,	1997

Web URL(s)

1. <https://nptel.ac.in/courses/112/107/112107217/>
2. <https://nptel.ac.in/courses/112/104/112104230/>
3. https://onlinecourses.nptel.ac.in/noc21_me66/preview

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

Total Periods **45**

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Ibrahim Zeid	Mastering CAD CAM	Tata McGraw-Hill Publishing Co.	2007
2	Radhakrishnan P, Subramanyan S. And Raju V	CAD/CAM/CIM	New Age International (P) Ltd, New Delhi	2000

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Chris McMahon and Jimmie Browne	CAD/CAM Principles", "Practice and Manufacturing management “	Pearson Education	1999
2	Donald Hearn and M. Pauline Baker	Computer Graphics	Prentice Hall, Inc	1992
3	Foley, Wan Dam, Feiner and Hughes	Computer graphics principles and Practice	Pearson Education	2003

Web URL(s)

1. <https://nptel.ac.in/courses/112/102/112102101/>
2. <https://nptel.ac.in/courses/112/102/112102102/>
3. <http://www.nptelvideos.in/2012/12/computer-aided-design.html>

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
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CO2	1	1	1	1	2				1	3		2	2	1
CO3	1	1	1	1	2				1	3		2	2	1
CO4	3	3	1	1	2				1	3		2	2	1
CO5	3	3	1	1	2				1	3		2	2	1
1 - Reasonably agreed 2 - Moderately agreed 3 - Strongly agreed														

U19MET78	Micro Electro Mechanical Systems	L	T	P	C
		3	0	0	3

Objectives:

- To impart knowledge of design, fabrication and characterization of Micro Electro Mechanical systems
- To provide basic knowledge of sensors and actuators to fabricate MEMS devices.
- To educate on the rudiments of Micro fabrication techniques.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- CO 1:** Apply the knowledge of basic science, circuit theory and electro-magnetic field theory in fabricating electro mechanical devices.
- CO 2:** Understand and analyze linear as well as digital electronic circuits
- CO 3:** Explain the different types of sensors and actuators used in MEMS.
- CO 4:** Discuss the different materials used for MEMS applications
- CO 5:** Educate on the applications of MEMS to disciplines beyond Electrical and Mechanical engineering.

Unit I INTRODUCTION 9

Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis – Flexural beam bending- Torsional deflection.

Unit II SENSORS AND ACTUATORS-I 9

Electrostatic sensors – Parallel plate capacitors – Applications – Interdigitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors - Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph - Applications – Magnetic Actuators – Micromagnetic components – Case studies of MEMS in magnetic actuators- Actuation using Shape Memory Alloys

Unit III SENSORS AND ACTUATORS-II 9

Piezoresistive sensors – Piezoresistive sensor materials - Stress analysis of mechanical elements – Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials – General Applications

Unit IV MICROMACHINING 9

Silicon Anisotropic Etching – Anisotropic Wet Etching – Dry Etching of Silicon – Plasma Etching – Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies - Basic surface micro machining processes – Structural and Sacrificial Materials – LIGA Process - Assembly of 3D MEMS – Foundry process.

Unit V POLYMER AND OPTICAL MEMS 9

Polymers in MEMS– Polimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS – Lenses and Mirrors – Actuators for Active Optical MEMS.

Total Periods 45

Text Books

S. No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Chang Liu	Foundations of MEMS	Pearson Education Inc	2006
2	Rai-Choudhury P	MEMS and MOEMS Technology and Applications	PHI Learning Private Limited	2009

Reference Books

S. No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Stephen D Senturia	Microsystem Design	Springer Publication	2000
2	Tai Ran Hsu	MEMS & Micro systems Design and Manufacture	Tata McGraw Hill, New Delhi	2002
3	Thomas M.Adams and Richard A.Layton	Introduction MEMS, Fabrication and Application	Springer Publication	2012
4	Julian w. Gardner, Vijay K. Varadan, Osama O. Awadelkarim	Micro Sensors MEMS and Smart Devices	John Wiley & Son LTD	2002

Web URL(s)

1. <https://nptel.ac.in/courses/117/105/117105082/>
2. <https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ee36/>
3. <http://www.nptelvideos.in/2012/12/mems-microsystems.html>
4. https://onlinecourses.nptel.ac.in/noc20_ee56/preview

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

U19MET79

Composite Materials

L	T	P	C
3	0	0	3

Objectives:

- To understand the fundamentals of composite material
- To learn about the benefits gained when combining different materials into a composite.
- To understand different processing methods, issues, properties and testing methods of different composite materials
- To study different types of laminates
- To study joining methods and analyse failure theories

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1 : Understanding of different material to design composites

CO2 : Study of different techniques to process different types of composites and know the limitations of each process

CO3 : Analyses of mathematical techniques to predict the macroscopic properties of different Laminates

CO4 : Study of different types of laminates and stresses computation

CO5 : Understanding of Joining methods and failure theories

Unit I INTRODUCTION 9

Definition – Composites –Reinforcements and matrices, Types of reinforcements – Types of Matrices – Types of Composites, Carbon Fibre composites - Properties of composites in comparison with standard materials. Applications of metals, ceramics and polymer matrices composites

Unit II MANUFACTURING METHODS 9

Hand and Spray Lay –Up, Injection molding, Resin injections, filament windings , Pultrusion , Castings and Prepregs, Fibre / Matrix Interface , Mechanical measurements of interface strength, Characterization of system; Carbon Fibre / epoxy , Glass Fibre / Polyester etc

Unit III MECHANICAL PROPERTIES - STIFFNESS AND STRENGTH 9

Geometrical aspects – Volume and Weight fraction , Unidirectional continuous fibre – discontinuous fiber, Short fibre system, Woven reinforcements – Mechanical testing; determinations of Stiffness and strength of unidirectional composite, tension , compression , flexure and shear

Unit IV LAMINATES 9

Plate stiffness and Compliance, Assumptions, Strains, Stress Resultants, Computation of stresses , Types of Laminates – Symmetric, Anti symmetric laminates, Balanced laminates, Quasi isotropic laminates, Cross – Ply laminates, Angle ply laminates, Orthotropic laminates, Laminate Moduli, Hydrothermal stresses

Unit V JOINING METHODS AND FAILURE THEORIES 9

Joining – Advantages and Disadvantages of adhesives and Mechanically fastened joints, Typical bond strengths and Test Procedures

Total Periods (L) 45

Text Books

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Mathews F. L. and Rawlings R. D	Composite Materials: Engineering and Science, 1 st Edition	Chapman and Hall, London, England	1994
2	Chawla K. K	Composite materials	Springer – Verlag	1998

Reference Books

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Clyne, T. W. and Withers, P. J	Introduction to Metal Matrix Composites	Cambridge University Press	1993
2	Strong, A.B	Fundamentals of Composite Manufacturing	SME	1989
3	Sharma, S.C	Composite materials	Narosa Publications	2000
4	Brounman, L.J. and Krock,R.M	Modern Composite Materials	Addison-Wesley	1967

Web URL(s)

1. <https://nptel.ac.in/courses/112/104/112104229/>
2. <https://nptel.ac.in/courses/112/104/112104221/>
3. <https://nptel.ac.in/courses/112/104/112104249/>

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

U19MET80	WIRE ARC ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

Objectives:

- To impart fundamentals of additive manufacturing processes
- To know various file formats, software tools, processes, techniques of AM
- To study fundamental Welding processes for AM
- To study and know about the essential testing required for WAAM component
- To understand Smart manufacturing, Industry 4.0 concepts and Industrial applications of WAAM

Course Outcomes:

At the end of this course, students will learn and enhance the ability to

- CO1 :** Brief the concept of additive manufacturing
- CO2 :** Understand the different welding processes available for additive manufacturing
- CO3 :** Analyze, differentiate and demonstrate the meaning of metal additive manufacturing
- CO4 :** Understand the different material properties to be studied and material characterization
- CO5 :** Explain Environmental and industrial importance of WAAM

Unit I ADDITIVE MANUFACTURING 9

Introduction - Basic Principles of Additive Manufacturing- Additive Manufacturing Processes- Data Sources - Software Tools - File Formats - Designing for Additive Manufacturing – Multiple Materials - Composite Materials - Aerospace, Automotive, Biomedical Applications of AM.

Unit II WELDING PROCESSES FOR ADDITIVE MANUFACTURING 9

Welding – Classification - Gas welding processes- uses - advantages, and limitations - Shielded Metal Arc Welding - Flux-cored Arc Welding - Gas Metal Arc Welding - Gas tungsten arc welding - plasma arc welding - Laser welding

Unit III WELDING BASED ADDITIVE MANUFACTURING 9

Wire Arc AM basics – WAM Process selection - Plasma deposition - TIG/MIG deposition - Laser welding based AM - Laser wire deposition - Electron Beam deposition – Optimization Techniques for WAAM - Distortion control methods - Defects and how to avoid them.

Unit IV TESTING OF COMPONENTS 9

Mechanical properties of metals - Dislocations and strengthening mechanisms – Failure - Grain structure and recrystallization - Development of microstructure and alteration of mechanical properties - Principles of metallographic examinations - Steel/Stainless Steels/Nickel and Aluminium, copper, and other non-ferrous alloys, Titanium - Heat treatments – Corrosion

Unit V INDUSTRIAL RELAVANCE OF WAAM 9

Smart Manufacturing - The Internet of Things – Prototyping – Industry 4.0 – Globalization - The Fourth Revolution - LEAN Production Systems - Cyber-Physical Systems - Next Generation Sensors – Cyber security in Industry 4.0, Basics of Industrial IoT – Advantages – Various real-time applications

Total Periods 45

Text/Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	R.S.Parmer	Welding Technology	Khanna Publishers, New Delhi	1992
2	Ramesh Chandra Panda	Industrial People Management	Saliha Publications, New Delhi	2021
3	Nadkarni S.V.	Modern Arc Welding Technology, 1st edition,	Oxford IBH Publishers	2005
4	AWS- Welding Hand Book	Welding Process	AWS- Welding Hand Book	2010
5	Davis A.C.	The Science and Practice of Welding	Cambridge University Press, Cambridge	1993
6	Cunningham, C. R., et al.	Invited review article: Strategies and processes for high quality wire arc additive manufacturing.	Additive Manufacturing	2018

Web URL(s)

1. https://books.google.co.in/books?id=YQC_zRppgcoC

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

U19MET81

HYDRAULICS AND PNEUMATICS

L	T	P	C
3	0	0	3

Objectives:

- To provide student with knowledge on the application of fluid power in process, construction and manufacturing Industries.
- To provide students with an understanding of the fluids and components utilized in modern industrial fluid power system.
- To develop a measurable degree of competence in the design, construction and operation of fluid power circuits.

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1 : Explain the Fluid power and operation of different types of pumps.

CO2 : Summarize the features and functions of Hydraulic motors, actuators and Flow control valves

CO3 : Explain the different types of Hydraulic circuits and systems

CO4 : Explain the working of different pneumatic circuits and systems

CO5 : Summarize the various trouble shooting methods and applications of hydraulic and pneumatic systems

Unit I FLUID POWER PRINCIPLES AND HYDRAULIC PUMPS 9

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps

Unit II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS 9

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols

Unit III HYDRAULIC CIRCUITS AND SYSTEMS 9

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

Unit IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits

Unit V TROUBLE SHOOTING AND APPLICATIONS 9

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs

Total Periods (L) 45

Text Books

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Anthony Esposito	Fluid Power with Applications	Pearson Education	2005
2	Majumdar S.R	Oil Hydraulics Systems- Principles and Maintenance	Tata McGraw Hill	2001

Reference Books

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Anthony Lal	Oil hydraulics in the service of industry	Allied publishers	1982
2	Dudelyt, A. Pease and John T. Pippenger	Basic Fluid Power	Prentice Hall	1987
3	Majumdar S.R	Pneumatic systems – Principles and maintenance	Tata McGraw Hill	1995
4	Michael J, Princhas and Ashby J. G	Power Hydraulics	Prentice Hall	1989
5	Shanmugasundaram.K,	Hydraulic and Pneumatic controls	Chand & Co	2006

Web URL(s)

1. <https://nptel.ac.in/courses/112/106/112106300/>
2. <https://nptel.ac.in/courses/112/105/112105047/>
3. <https://nptel.ac.in/courses/112/105/112105046/>

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

Objectives:

- To develop and strengthen entrepreneurial quality and motivation in students.
- To impart basic entrepreneurial skills and understanding to run a business efficiently and effectively

Course Outcomes: Upon completing this course, the students will be able to

- CO1 :** Identify the role of Entrepreneurship and study factors affecting entrepreneurial growth.
- CO2 :** Apply motivational techniques for effective stress management in entrepreneurship development.
- CO3 :** Gain knowledge and skills needed to run a business successfully.
- CO4 :** Apply knowledge on sources of finance for managing working capital
- CO5 :** Discuss Government policies for small scale enterprises and gain knowledge

Unit I ENTREPRENEURSHIP 9

Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur
Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.

Unit II MOTIVATION 9

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self Rating, Business Games, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.

Unit III BUSINESS 9

Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies

Unit IV FINANCING AND ACCOUNTING 9

Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, Management of working Capital, Costing, Break Even Analysis, Taxation – Income Tax, Excise Duty – Sales Tax.

Unit V SUPPORT TO ENTREPRENEURS 9

Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures - Business Incubators – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting

Total Periods: 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Khanka. S.S.,	Entrepreneurial Development	S.Chand & Co. Ltd., Ram Nagar, New Delhi	2013
2	Donald F Kuratko	Entrepreneuership – Theory, Process and Practice, 9 th Edition	Cengage Learning,	2014

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Hisrich R D, and Peters M P,	Entrepreneurship 8 th Edition	Tata Mc Graw Hill	2018
2	Mathew J Manimala	Enterprenuership theory at cross roads: paradigms and praxis” 2n d Edition	Dream tech	2005
3	Rajeev Roy	Entrepreneurship 2 nd Edition	Oxford University Press	2011

Web URL(s):

1. <https://www.classcentral.com/course/swayam-entrepreneurship-development-19847>
2. https://onlinecourses.swyam2.ac.in/ntr21_ed08/preview
3. <https://nptel.ac.in/>

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

Objectives:

- To impart knowledge about the elements and techniques involved in Mechatronics systems which are very much essential to understand the emerging field of automation

Course Outcomes: Upon completing this course, the students will be able to

- CO1 :** Discuss the interdisciplinary applications of Electronics, Electrical, Mechanical and Computer Systems for the Control of Mechanical and Electronic Systems.
- CO2 :** Classify the actuation and sensor systems based on the principle of operation and application
- CO3 :** Discuss Mechatronic components and systems using the basic building blocks of various systems mathematically, along with different modes of controller.
- CO4 :** Explain the architecture, programming and application of programmable logic controllers to problems and challenges in the areas of Mechatronic engineering.
- CO5 :** Discuss a Mechatronic system using the knowledge and skills acquired through the course and also from the given case studies

Unit I INTRODUCTION 9

Introduction to Mechatronics – Systems – Concepts of Mechatronics approach – 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 MICROPROCESSOR AND MICROCONTROLLER 9

Introduction – Architecture of 8085 – Pin Configuration – Addressing Modes – Instruction set Timing diagram of 8085 – Concepts of 8051 microcontroller – Block diagram.

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 – Basic structure – Input and output processing – Programming – Mnemonics – Timers, counters and internal relays – Data handling – Selection of PLC.

Unit V ACTUATORS AND MECHATRONIC SYSTEM DESIGN 9

Types of Stepper and Servo motors – Construction – Working Principle – Advantages and Disadvantages. Design process-stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Engine Management system – Automatic car park barrier

Total Periods: 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Ramesh S Gaonkar	Microprocessor Architecture, Programming, and Applications with the 8085	Prentice Hall India Ltd	2008
2	Bolton	Mechatronics	Prentice Hall	2008

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Krishna Kant	Microprocessors & Microcontrollers	Prentice Hall India Ltd	2007
2	Devadas Shetty and Richard A. Kolk,	Mechatronics Systems Design	PWS publishing company	2007
3	Clarence W, de Silva	Mechatronics, First Indian Reprint	CRC Press	2012
4	Michael B.Histand and Davis G.Alciatore	Introduction to Mechatronics and Measurement systems International edition	McGraw Hill	2007

Web URL(s):

1. https://onlinecourses.nptel.ac.in/noc21_me27/preview
2. https://onlinecourses.nptel.ac.in/noc21_me129/preview

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

Objectives:

- To enable the students to create an awareness on Engineering Ethics and Human Values to instill moral and social values, loyalty and to appreciate the rights of others..

Course Outcomes: Upon completing this course, the students will be able to

- CO1 :** Explain human values and their importance in society,
CO2 : Apply engineering ethics in society and use ethical theories.
CO3 : Apply code of ethics and engineering as experimentation
CO4 : Realize the responsibilities, safety and rights in the society.
CO5 : Discuss the global ethical issues related to engineering and

Unit I HUMAN VALUES**9**

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self- confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management

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.

Unit III ENGINEERING AS SOCIAL EXPERIMENTATION**9**

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

Unit IV SAFETY, RESPONSIBILITIES AND RIGHTS**9**

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

Unit V GLOBAL ISSUES**9**

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership – Code of Conduct – Corporate Social Responsibility

Total Periods: 45**Text Books**

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Mike W. Martin and Roland Schinzinger	Ethics in Engineering	Tata McGraw Hill, New Delhi	2003
2	Govindarajan M, Natarajan S, and Senthil Kumar V.S,	Engineering Ethics	Prentice Hall of India, New Delhi,	2004

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Charles B. Fleddermann	Engineering Ethics	Pearson Prentice Hall, New Jersey	2004
2	John R Boatright,	Ethics and the Conduct of Business	Pearson Education, New Delhi	2003
3	Laura P. Hartman and Joe Desjardins	Business Ethics: Decision Making for Personal Integrity and Social Responsibility	Mc Graw Hill education India Pvt. Ltd.,New Delhi	2013
4.	World Community Service Centre	Value Education	Vethathiri publications, Erode	2011

Web URL(s):

1. www.onlineethics.org
2. www.nspe.org
3. www.globalethics.org
4. www.ethics.org

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

Objectives:

- To provide knowledge about various optimization techniques for solving the engineering and business problems.

Course Outcomes: Upon completing this course, the students will be able to

CO1 : Formulate and select the suitable method to solve the linear programming problem

CO2 : Solve the different transportation and assignment-based models.

CO3 : Draw the network models and solve it.

CO4 : Select the suitable queuing model and solve the given applications.

CO5 : Find the total elapsed time and optimum replacement policy.

Unit I LINEAR PROGRAMMING**9**

Operations Research - Introduction, Scope, Objectives, Phases and its limitations. Linear Programming Problem(LPP) Formulation, Graphical method, Simplex method. Artificial variable techniques - Big-M method and two-phase method

Unit II TRANSPORTATION AND ASSIGNMENT MODEL**9**

Transportation - Introduction, Initial basic feasible solutions - Northwest corner rule, Least cost method and Vogel's approximation method. Optimality test using MODI method. Assignment - Introduction and Hungarian method for optimal solution. Travelling salesman problem

Unit III NETWORK MODELS AND PROJECT MANAGEMENT**9**

Network models - Introduction, Rules for construction and errors. Shortest route - Dijkstra's algorithm, Minimal spanning tree - Kruskal's algorithm, Maximum flow models. Project management - CPM and PERT networks.

Unit IV QUEUING MODELS**9**

Queueing model - Introduction , elements, Kendall's Notation, parameters, Single Server and multi-server models, Poisson input, Exponential service, Constant rate service, Finite and Infinite population.

Unit V SEQUENCING AND REPLACEMENT MODEL**9**

Sequencing Problem - Introduction, Types - n jobs with 2 machines and n jobs with 3 machines. Replacement Models - Introduction, Types, Replacement of items that deteriorate with time, Value of money changing with time and not changing with time, Optimum replacement policy - Individual and Group replacement policy

Total Periods: 45**Text Books**

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Taha H.A.,	Operations Research Sixth Edition	Prentice Hall of India	2003
2	Prem Kumar Gupta, D. S. Hira	Introduction to Operations Research	S.Chand and Co	2004

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Frederick S. Hiller, Gerald J. Liberman	Operations Research Concepts and Cases, 8 th edition	Tata McGraw-Hill Publishing Company Private Limited	2010
2	R. Panneerselvam	Operations Research, Second edition	Prentice Hall of India	2010
3	Hamdy A. Taha	Operation Research - An Introduction	Pearson Publications	2010
4.	Wagner	Operations Research	Prentice Hall of India	2000

Web URL(s):

1. https://onlinecourses.swayam2.ac.in/cec20_ma10/preview
2. https://onlinecourses.nptel.ac.in/noc20_ma23/preview
3. https://onlinecourses.nptel.ac.in/noc19_ma29/preview

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

Objectives:

- To sensitize the Engineering students to various aspects of Human Rights.

Course Outcomes: Upon completing this course, the students will be able to

- CO1 :** Explain the meaning of Human Rights and its classification
- CO2 :** Understand the various theories of Human Rights and their background.
- CO3 :** Explain the international laws of Human Rights and monitoring agencies
- CO4 :** Recognize Human Rights in India and its constitutional provisions
- CO5 :** Implement Human Rights in different circumstances.

Unit I INTRODUCTION TO HUMAN RIGHTS 9

Human Rights – Meaning, origin and Development. Notion and classification of Rights – Natural, Moral and Legal Rights. Civil and Political Rights, Economic, Social and Cultural Rights; collective / Solidarity Rights.

Unit II THEORIES OF HUMAN RIGHTS 9

Evolution of the concept of Human Rights Magna carta – Geneva convention of 1864. Universal Declaration of Human Rights, 1948. Theories of Human Rights.

Unit III INTERNATIONAL LAWS 9

Theories and perspectives of UN Laws – UN Agencies to monitor and compliance

Unit IV INDIAN LAWS 9

Human Rights in India – Constitutional Provisions / Guarantees

Unit V IMPLEMENTATION OF HUMAN RIGHTS 9

Human Rights of Disadvantaged People – Women, Children, Displaced persons and Disabled persons, including Aged and HIV Infected People. Implementation of Human Rights – National and State Human Rights Commission – Judiciary – Role of NGO's, Media, Educational Institutions, Social Movements.

Total Periods: 45

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Kapoor S.K.,	“Human Rights under International law and Indian Laws”,	Central Law Agency, Allahabad	2014
2	Chandra U.,	“Human Rights”	Allahabad Law Agency, Allahabad	2014
3	Upendra Baxi	The Future of Human Rights	Oxford University Press, New Delhi	2009

Web URL(s):

1. https://onlinecourses.swayam2.ac.in/cec20_hs24/preview
2. https://onlinecourses.swayam2.ac.in/cec21_lw07/preview
3. <https://nptel.ac.in/>

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

U19MET87	Non-Destructive Testing and Evaluation	L	T	P	C
		3	0	0	3

Objectives:

- To study and understand the various Non Destructive Evaluation and Testing methods, theory and their industrial applications.

Course Outcomes: Upon completing this course, the students will be able to

- CO1 :** Explain the fundamental concepts of NDT
- CO2 :** Discuss the different surface testing methods .
- CO3 :** Explain the concept of Thermography and Eddy current testing
- CO4 :** Explain the concept of Ultrasonic Testing and Acoustic Emission
- CO5 :** Explain the concept of Radiography

Unit I OVERVIEW OF NDT 9

NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT., Visual inspection – Unaided and aided

Unit II SURFACE TESTING METHODS 9

Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

Unit III THERMOGRAPHY AND EDDY CURRENT TESTING 9

Thermography- Principles, Contact and non contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications - .Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation

Unit IV ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION 9

Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique –Principle, AE parameters, Applications

Unit V RADIOGRAPHY 9

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography

Total Periods: 45

Text Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Baldev Raj, T.Jayakumar, M.Thavasimuthu	Non-Destructive Testing Techniques 1 st Revised Edition	New Age International Publishers	2010
2	Baldev Raj, T.Jayakumar	Practical Non-Destructive Testing	Narosa Publishing House	2010

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Paul E Mix	Introduction to Non-destructive testing: a training guide 2nd Edition	Wiley, New Jersey,	2005
2	Mc Gonnagle	Non-Destructive Testing	McGraw Hill Book Co	2008
3	Barry Hull and Vernon John	Non-Destructive Testing	Macmillan	2009

Web URL(s):

1. https://onlinecourses.nptel.ac.in/noc22_mm13/preview
2. <https://www.digimat.in/nptel/courses/video/113106070/L01.html>
3. <https://nptel.ac.in/>

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

Objectives:

- To familiarize the students with the safety issues in design, handling and industrial environment.

Course Outcomes: Upon completing this course, the students will be able to

- CO1 :** Take suitable preventive measure in industries in order to minimize the accidents.
- CO2 :** Implement safety procedure in material handling industries.
- CO3 :** Implement safety procedure in chemical industries.
- CO4 :** Conduct environmental impact assessment and basic safety inspections using strategies that they have developed.
- CO5 :** Create a document addressing the principles for developing and implementing a successful occupational health and safety program and evaluation of a work site.

Unit I ACCIDENT PREVENTION**9**

Definitions and theories- Accident - Injury - Unsafe act - Unsafe condition - Dangerous occurrence - Theories and principles of accident causation - Cost of accidents - Accident reporting and investigations - Safety committees - Need – Types - Advantages. Safety education and training - Importance - Various training methods - Accident prevention - Motivating factors - Safety suggestion schemes. Definitions connected with measuring safety performance as per Indian and International standards

Unit II SAFETY IN MATERIAL HANDLING**9**

General safety consideration in material handling - Ropes, Chains, Sling, Hoops, Clamps, Arresting gears - Prime movers. Ergonomics consideration in material handling, design, installation, operation and maintenance of conveying equipment, hoisting, traveling and slewing mechanisms. Selection, operation and maintenance of industrial trucks - Mobile cranes - Tower crane

Unit III SAFETY IN CHEMICAL INDUSTRIES**9**

Safety in the design process of chemical plants - Safety in operational and maintenance - Exposure of personnel - Operational activities and hazards - Safety in storage and handling of chemicals and gases - Hazards during transportation - Pipeline transport - Safety in chemical laboratories. Specific safety consideration for cement, paper, pharmaceutical, petroleum, petro - chemical, rubber, fertilizer and distilleries.

Unit IV ENVIRONMENTAL IMPACT ASSESSMENT**9**

Evolution of EIA - Concepts - Methodologies - Screening - Scoping - Checklist – Rapid and Comprehensive EIA - Legislative and environmental clearance procedure in India - Prediction tools for EIA. - Assessment of Impact - Air - Water - Soil - Noise- Biological. Socio cultural environment - Public participation - Resettlement and Rehabilitation. - Documentation of EIA

Unit V REGULATIONS FOR HEALTH, SAFETY AND ENVIRONMENT**9**

Factories act and rules; - Indian explosive act - Gas cylinder rules – Environmental pollution act - Indian petroleum act and rules - Oil industry safety directorate (OISD) - Indian Electricity act and rules. - Mines act and rules - Indian motor vehicles act and rules.

Total Periods: 45**Text Books**

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Handlin.W	Industrial Hand Book	McGraw-Hill	2008
2	Anton.T.J	Occupational safety and health management	McGraw Hill,	2009

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Heinrich.H.W	Industrial Accident Prevention	McGraw Hill,	2000
2	Rudenko.N	Material Handling Equipments	Mir Publishers, Moscow	1991
3	Lees.F.P	Loss “Prevention in Process Industries	Butterworths, NewDelhi	1996
4.	Canter.R.L,	Environmental Impact Assessment	McGraw Hill	2000

Web URL(s):

1. https://onlinecourses.nptel.ac.in/noc20_mg43/preview
2. <https://www.classcentral.com/course/swayam-industrial-safety-engineering-14124>
3. <https://www.edvicer.com/course/industrial-safety-engineering-swayam>

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

Objectives:

- To give an idea about Intellectual Property Rights registration and its enforcement.

Course Outcomes: Upon completing this course, the students will be able to

- CO1 :** Explain the basic concepts of IPR and their importance ,
- CO2 :** Understand the practical aspects of registration of copy rights, trademarks, and patents
- CO3 :** Explain various agreements and Acts related to IPR.
- CO4 :** Discuss the various laws related to intellectual property and digital content protection..
- CO5 :** Understand the enforcement measure to be followed for Infringement of IPRs

Unit I INTRODUCTION**9**

Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

Unit II REGISTRATION**10**

Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad

Unit III AGREEMENTS**10**

International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

Unit IV DIGITAL PRODUCTS AND LAW**9**

Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.

Unit V ENFORCEMENT**7**

Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies

Total Periods: 45**Text Books**

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	V. Scople Vinod	Managing Intellectual Property	Prentice Hall of India, New Delhi,	2012
2	Prabuddha Ganguli	Intellectual Property Rights: Unleashing the Knowledge Economy	McGraw Hill Education	2011

Reference Books

S.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Dr. R. Radhakrishnan and Dr.S. Balasubramanian	Intellectual Property Rights”,	Excel Books	2018
2	Deborah E. Bouchoux	Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets” Third Edition	Cengage Learning,	2012
3	Neeraj Pandey and ani Dharni Khushdeep	Intellectual Property Rights	Mc Graw Hill Education India Pvt. Ltd. New Delhi	2013
4.	Ramakrishna B and anil Kumar H.S	Fundamentals of Intellectual Property Rights- for students, Industrialist and Patent Lawyers	Notion Press	2017

Web URL(s):

1. https://onlinecourses.nptel.ac.in/noc22_hs59/preview
2. https://onlinecourses.swayam2.ac.in/cec20_hs18/preview
3. <https://nptelswayam.com/nptel/patent-and-intellectual-property-rights%E2%80%8B/>

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